Potato Growing IN THE SOUTH

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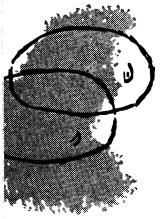

Potato Growing IN THE SOUTH

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The potato is a major farm crop in nearly all the Southern States. It is grown in the South chiefly as an early crop, because it produces larger and better yields if grown at temperatures averaging not more than about 70° F. Early-crop southern potatoes produce smaller quantities of tubers than late-crop potatoes grown in other regions, but their yield usually brings prices high enough to make up for the difference in quantity.

For reasons of climate, the characteristics that make a potato variety suitable to be grown in the South differ somewhat from those of many varieties suitable to be grown in the North. In the earliest producing areas of the South, red varieties are preferred; elsewhere in the region, white varieties are grown more commonly.

This bulletin, which discusses all the main features of potato growing, contains information needed by growers of table stock in the States of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia. Farmers in elevated areas of North Carolina, Maryland, and Tennessee and elsewhere in the South who are interested in producing seed potatoes will find helpful information in Department of Agriculture Circular 764, Production of Disease-Free Seed Potatoes.[1]

NEEDS OF THE POTATO PLANT

The yield of tubers and the shape and general attractiveness of the tubers depend to a great extent on the quality of the soil. The best potato soils of the South are well-drained loams well supplied with organic matter and available plant nutrients. Potatoes should not be planted in soils that crack badly and would stick to the tubers. Heavy soils are hard to prepare, tend to puddle when wet, and are likely to produce ill-shaped tubers. In poorly drained soils, water filling the pores keeps out air with the result that essential chemical reactions cannot take place, dead plant material in the soil cannot decompose normally, and potato roots cannot make vigorous growth. Also, potato seed pieces planted in wet soils often rot. Even a light sandy topsoil cannot produce satisfactory crops of potatoes if the subsoil underlying it is slow to drain. Unless a soil has good natural drainage, it should be drained artificially before it is used for growing potatoes.

[1] This circular is supplied at the price of 20 cents per copy by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Areas of sandy soil that tends to blow, is subject to leaching, or cannot hold normal quantities of water should not be used for growing potatoes, because on such areas the vines ripen prematurely and yields fall short of normal.

The potato needs a steady, ample supply of soil moisture, particularly from the time the tubers begin to form until just before harvest. A long dry period followed by heavy rain often causes the tubers to become rough and knobby.

If frost does severe damage to the vines while the tubers are forming, this may stop tuber development; and if growth begins again after being checked in this way, the tubers may become knobby.

CULTIVATING AND CONSERVING THE SOIL

As a rule the potato grower should plow his soil deeply, to provide for good root development. In a deep and fertile soil, the plow should cut to a depth of 8 to 10 inches or more. In a shallow soil, however, it should not go more than 1 inch below the plow depth of the previous year. A 14-inch or larger plow is needed. Where much trash is to be turned under, the job calls for a 16- or 18-inch plow with a large clearance. Plowing should be done at such a time that the plant material plowed under can become well decomposed before the potato seed go into the ground. Often the soil is plowed into narrow ridges. This provides for good drainage and permits early preparation of the seedbed.

Soil should never be plowed when too wet; otherwise, it is likely to remain in poor condition throughout the growing season.

A few days before potatoes are planted, the soil should be thoroughly fitted with a disk or a cutaway harrow. Planting time should find the soil loose and friable, not lumpy or filled with coarse, undecayed plant material.

Soil erosion can become a serious problem for the potato grower; the importance of controlling it cannot be overemphasized. Erosion losses come from various causes, so no single remedy can be recommended as a cure-all. The Soil Conservation Service of the United States Department of Agriculture and State and county agricultural agencies are cooperating with farmers in a nationwide program demonstrating soil-conservation practices. Any farmer faced by an erosion problem should go to his local soil-conservation agency for advice.

The southern potato grower cultivates his planted fields chiefly to kill weeds and to make it possible for the surface soil to absorb more water. Ways of doing this work vary among the different potato-producing areas of the South and according to type of soil. The first cultivation should be a deep one close to the plants. Sometimes it is given with a turnplow, which throws the soil into ridges. Later cultivations should be shallower and farther away from the plants, else they will cut roots and reduce yields. If rain follows shortly after planting, the soil should be cultivated as soon as it has dried enough. Loosening the soil at this time helps to keep seed pieces from suffocating and rotting.

IMPROVING THE SOIL

COMMERCIAL FERTILIZERS

A potato crop absorbs rather large quantities of plant nutrients, particularly nitrogen and potassium. In order to apply commercial fertilizers so as to help meet the needs of the soil of a particular piece of land, the grower usually must have had experience with soil of the same type and know how the

area has been treated in the past. Some general information on use of fertilizer is given here. For specific advice on kind, amount, ratio, and placement of fertilizer, the grower should consult his county agent or State agricultural college.

The most satisfactory fertilizers for the potato plant contain nitrogen, phosphoric acid, and potash. In the Homestead district of Florida, where soils have been found to lack sufficient manganese, satisfactory results have followed application of 100 pounds of 65-percent manganese sulfate per ton of fertilizer. In Baldwin County, Ala., potato growers apply 8–4–2, which contains the equivalent of 40 pounds of magnesium oxide per ton, at planting time at a rate of about 1,500 pounds per acre. Six weeks later they apply 8–4–2 to the potato rows as a side dressing at a rate of about 1,000 pounds per acre.

In order to make sure that the vines will grow rapidly and the tubers will develop well, the nutrients needed by the potato plant must be supplied when it first begins to grow. Consequently all the fertilizer that is to be used on a crop, or nearly all, is applied at planting time.

The best method of applying fertilizer to potatoes is to place it in bands about 2 inches away from the seed pieces and at their level or slightly below it. On sloping land the fertilizer should be placed about an inch below the seed-piece level. Side placement of fertilizer has been adopted as a standard practice by many potato growers along the Atlantic seaboard. Horse-drawn and tractor-drawn potato planters equipped with either one or several rows of fertilizer depositors are now available on the market. Each of these machines has a pair of single-disk furrow openers that can be adjusted to place the fertilizer bands at the right distance from the row and at the desired depth.

Fertilizer should never be applied so that it comes into direct contact with potato seed pieces or be deposited directly over them. If it touches seed pieces it delays sprouting, weakens the plants, and greatly reduces yields. On an area in Virginia, for example, 4-year yield averaged 21 bushels per acre higher where fertilizer was placed at the side than where the same quantity of the same fertilizer was mixed with the soil in the row; on an area in New Jersey the corresponding difference was 18 bushels, and on one in Michigan it was 29 bushels. Tests in other States gave similar results.

BARNYARD MANURE

Barnyard manure, if added to soil, improves its physical condition, adds plant food to it, and increases the activity of beneficial soil bacteria. If manure is available, the potato grower is advised to broadcast it on the land at a rate of 6 to 8 tons per acre before plowing. Light applications of manure do more good than heavy ones. Generally, it is considered good practice to add 40 to 50 pounds of ordinary superphosphate to each ton of manure. This is unimportant, however, where complete fertilizer is used in addition to the manure.

Fresh manure should not be applied just before a potato crop is planted; if applied at that time it may create conditions favorable for common scab, particularly if the soil's reaction is not acid enough to be unfavorable to scab.

Manure should be taken care of in a way that prevents loss of valuable plant nutrients. It should never be piled loosely in the open barnyard or allowed to accumulate under the eaves of the barn, because in either situation nutrients are likely

to be leached out of it. It should be kept moist and compact. If it is piled in the open, the pile should have a slightly depressed top and nearly vertical sides and should be kept moist throughout to avoid overheating and loss of nitrogen.

GREEN MANURE

The high temperatures prevailing in the South cause dead plant materials in the soil to decompose rather rapidly. Unless the loss is made up in some way, agricultural soil becomes less and less well supplied with this organic matter. Where potatoes are grown each year, green-manure crops should be used to help maintain the soil's organic-matter content. In the early-potato sections a summer legume such as cowpeas can be planted after the potato harvest and turned under the same year.

CROP ROTATION

For best results, potatoes should not be grown year after year on the same land. Higher yields and better quality can be obtained by growing them in rotation with other crops. Crop rotation helps to maintain and increase the soil's percentage of organic matter, to control weeds, and to reduce crop losses from disease.

Desirable crop rotations vary among potato-producing areas in the South according to local conditions. Helpful advice on choice of crops and order of planting can be obtained from your county agent or agricultural college.

VARIETIES GROWN

Southern potato growers are interested primarily in varieties that require 90 days or less to mature and that grow fast enough during the short days of winter and early spring to produce satisfactory early yields. A variety that requires more than about 90 days to develop tubers is not suitable for commercial production in the South. The national potato-breeding program conducted cooperatively by the United States Department of Agriculture and the State agricultural experiment stations has led to the development of a number of new varieties that are superior to the older ones for production in the South. Varieties now grown commercially in the South include the following:

De Soto.—De Soto, derived from a cross between Triumph and Katahdin, has vigorous, upright growing vines and round to oblong tubers with red or purplish-red skin. De Soto is resistant to mild mosaic and matures medium early.

Katahdin.—Katahdin is a late maturing white variety adapted to a wide range of conditions. The tubers are large, elliptical to roundish, and medium thick, with smooth skin of a dark creamy buff color and shallow eyes.

Kennebec.—Kennebec, a high yielding new variety, has been grown commercially on a limited scale in the South, generally with excellent results. In this region it produces white, oblong tubers. The seed pieces must be spaced closely to prevent tubers from growing too large. Kennebec is resistant to the common form of late blight, to mild mosaic, and to net necrosis. In 1950 considerable tuber rot developed in it both in Louisiana and in Alabama. The trouble appeared to result from physiological breakdown, presumably due to unfavorable growing conditions. Kennebec will have to be tested further in the South before it can be recommended for extensive commercial production in this region.

La Soda.—La Soda was derived from a cross between Triumph and Katahdin. Its tubers vary from

roundish to slightly oblong. They have very smooth skin, bright pinkish red in color, and medium deep to very shallow eyes. La Soda matures early to medium early. In several places in the South it has outyielded Triumph and seems to be more resistant to adverse growing conditions. It has no disease resistance. A sport of La Soda has been found that produces tubers of a much brighter red color and otherwise has all the standard characteristics of the variety. This is being increased for commercial production.

Pontiac.—Pontiac is a red variety developed from a cross between Triumph and Katahdin. It produces high yields. The tubers tend to grow too large under favorable conditions, but their size can be controlled to a certain extent by spacing the seed pieces closely in the row. The tubers are oblong to round and blunt at the ends. The skin is smooth or, less commonly, netted. The eyes are of medium depth.

Sebago.—Sebago, developed from a cross between Chippewa and Katahdin, is a medium late, high yielding white variety grown extensively in the South, especially in Baldwin County, Ala., and in the Hastings area of Florida. The tubers are large, elliptical or round-elliptical, and medium thick, with smooth ivory-yellow skin and shallow eyes. Sebago is resistant to mild mosaic, net necrosis, and yellow dwarf and is mildly resistant to late blight in both vines and tubers and to brown rot. The tubers are suitable for potato chips if stored at 55° F. or conditioned at 70° after being stored at 40°.

Sequoia.—Sequoia is a late, high yielding white variety of good shape, selected from a cross of Green Mountain and Katahdin. It grows satisfactorily in the South only in the more elevated parts of North Carolina and Tennessee. The tubers are large, roundish, and flattened, with smooth skin. The eyes are shallow except at the apex. Sequoia is resistant to flea beetle and leafhopper injury, and its foliage is mildly resistant to late blight. The tubers are not suitable for potato chips.

Triumph.—Triumph is an early red variety grown commercially in most of the potato-producing areas of the United States outside the Northeastern States. In the South it was formerly almost the only red variety grown but now is gradually being replaced by others. Under favorable conditions Triumph produces high yields, but it is susceptible to all the common potato diseases. The tubers are round and thick, with eyes of medium depth and smooth skin. They are not suitable for potato chips.

CERTIFIED SEED

Comercial potato growers should always use certified seed. Although it costs more than the uncertified, the extra cost is small in view of the greater yield that can be expected. Using high-quality seed practically free of infection is particularly important in potato production because a number of potato diseases affecting both yield and quality are caused by organisms carried inside the tuber, where they are not affected by external treatments. In many cases no sign of the presence of infection appears on the outer surface of the tuber. This is true of the wilt, some of the bacterial diseases, and nearly all the viruses. When an infected seed piece is planted, not only does the disease reappear in any plant grown from that piece but the whole crop is exposed to spread of the infection.

Certified potato seed is grown chiefly in northern areas, where lower growing temperatures favor

the expression of virus diseases. Growers specializing in production of certified seed use all available methods to eliminate infections from their seed stock so that their fields will meet the rigid requirements of a State certification service. Infected plants can be detected in the seed field and removed before infection can spread. In the 40 years since seed-potato certification in the United States was begun, to provide growers of table stock with seed that are disease resistant and true to varietal name, the enforcement of more and more rigid standards has helped considerably to improve the quality of certified seed.

DISINFECTING SEED

Before planting potatoes on new land, or on old land not heavily infested with the scab fungus or some other disease-causing organism, it is generally advisable to treat the seed for control of rhizoctonia and other skinborne diseases. If heavily scabbed potatoes must be used for planting on clean land (they should not be so used if it can be avoided), they should by all means be disinfected thoroughly. If soil is already infested with the scab fungus, treating seed that are to be planted in it will have practically no effect on the amount of scab that develops.

Diseases caused by viruses and by fungi that are carried inside the tuber cannot be controlled by using disinfectants.

Treatments recommended for disinfecting seed potatoes include mercuric chloride (corrosive sublimate), acidulated mercuric chloride, and formaldehyde. Any disinfecting treatment should be given before rather than after the potatoes are cut.

Any questions on the advisability of treating seed potatoes or methods of treating them in your locality should be taken up with your State agricultural college.

MERCURIC CHLORIDE

A 1-to-1,000 solution of mercuric chloride (corrosive sublimate) is made up of 4 ounces of the chemical and 30 gallons of water. Mercuric chloride goes into solution very slowly in cold water; it should therefore be dissolved separately in a small quantity of hot water. The solution should never be put into metal containers unless they have been coated with asphaltum or some other protective material. Potato tubers are immersed in the solution from 1½ to 2 hours.

The mercuric chloride solution decreases in strength with use. To correct this, three-eighths ounce of the chemical should be added for every 3 bushels of potatoes treated for 2 hours. If a shorter treatment is given, the amount of chemical added should be proportionally less. Enough water should be added each time to bring the solution up to its original volume. After four treatments, make up a fresh solution.

Wetting the potatoes 24 hours before treating them helps to remove dirt, softens any sclerotia of *Rhizoctonia* that may be present, and makes disinfection more effective.

Mercuric chloride is a deadly poison. Even a solution of 1 part of the chemical to 1,000 parts of water is poisonous. Buy only small quantities, according to need, and if you store any surplus label it carefully and put it where it will not be accessible to children. Plainly mark any potatoes treated with mercuric chloride and store them in such a way that they cannot be mistaken for potatoes intended to be eaten by humans or livestock.

ACIDULATED MERCURIC CHLORIDE

Potatoes can be disinfected more quickly with an acid-mercury dip. To make this, prepare a 1-to-500 mercuric chloride solution by dissolving 8 ounces of mercuric chloride in 30 gallons of water and add 1 part of commercial hydrochloric (muriatic) acid to 99 parts of the solution. The tubers are soaked in the solution for only 5 minutes. This method disinfects the tubers as effectively as the long-soak mercuric chloride treatment. If the treated tubers are not planted immediately, they must be spread out to dry; otherwise they may be seriously injured by the solution.

In preparing and using acidulated mercuric chloride, observe the same precautions as with mercuric chloride. Remember that strong hydrochloric acid is very caustic.

COLD FORMALDEHYDE

Cold-formaldehyde treatment of seed potatoes is useful for the control of common scab, but it does not effectively control rhizoctonia. To make the solution, add 1 pint of formalin (40-percent formaldehyde) to 30 gallons of water. (The solution does not corrode metal.) Soak the tubers 2 hours in the solution for scab control.

Formaldehyde solution is very poisonous at full strength (40 percent). As diluted for use it is irritating to the skin and gives off fumes that are irritating to eyes, nose, and throat. In using the solution, protect the hands with rubber gloves. If indoors, use a gas mask with a suitable canister.

HOT FORMALDEHYDE

Hot-formaldehyde treatment of seed potatoes has given satisfactory control of common scab, but for the control of rhizoctonia it is not quite so effective as the mercuric chloride treatment. The hot formaldehyde solution is made by adding 2 pints of formalin to 30 gallons of water held at a temperature between 124° and 126° F. It is important to maintain the temperature of the solution between these limits during treatment, because higher temperatures would cause injury to the sprouts and at lower temperatures the solution would not thoroughly disinfect the potatoes. If a jet of live steam is used for heating the solution, 0.9 pint of formalin should be added for every 50 bushels of whole seed treated. Covering the tubers with canvas or burlap for an hour after treatment adds to the effectiveness of this method.

In Dade County, Fla., the hot-formaldehyde method is used extensively to treat certified seed as it is unloaded from railroad cars. The treated seed is then either planted directly or stored for a short period. With an efficient treating unit, as many as 2,400 100-pound sacks of seed potatoes can be disinfected in 12 hours.

CUTTING AND HEALING SEED PIECES

Seed potatoes may be cut by hand or with a machine. Several seed-cutting machines are on the market, most of them operated by power. Although power-operated machines can do the cutting faster, they are likely to produce some seed pieces without eyes—especially if the eyes of the potatoes are few or are not well distributed.

Where ring rot, a highly infectious bacterial disease of the potato, may be present, seed is often cut with a machine having one or more power-driven circular knives which revolve in a disinfecting solution. Disinfecting the knives keeps them from spreading ring rot from infected to noninfected potatoes. Some growers use boiling water as the disinfectant, others use a mer-

curic chloride (corrosive sublimate) solution. The mercuric chloride is dissolved in water at the rate of 1 ounce to 4 gallons and a fresh solution is used when 7 or 8 sacks of potatoes have been cut.

Seed pieces should weigh 1½ to 2 ounces and have 1 to 3 eyes each. Blocky seed pieces are desirable (fig. 1), as they can be handled better in the planter and are less liable to decay in the ground.

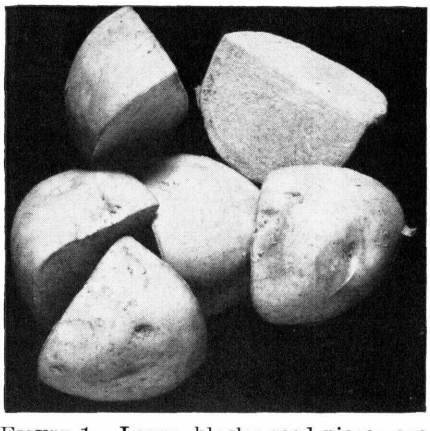

FIGURE 1.—Large, blocky seed pieces are more likely to produce even stands than smaller ones.

One of the main causes of seed-piece rot in the field is lack of proper healing of the cut surfaces. This healing is usually called suberization, or corking over. Seed pieces that are partly rotted before they sprout may produce weak plants, which turn yellow and usually die prematurely, or no plants at all.

Suberization of seed pieces can be brought about by exposing them to high humidity, a temperature of 60° to 70° F., and plenty of air. Under these conditions a protective layer of cork cells develops at the cut surfaces of the seed pieces, which forms an effective barrier against the decay-producing organisms that are always present in the soil. Fresh-cut seed pieces, when planted in moist, warm soil, usually heal over in the soil before decay-producing organisms have a chance to invade them; however, since it is not difficult and is safer, every grower should suberize his seed pieces before planting them.

Any suberization method can usually be adapted successfully to local variations in temperature and humidity. Good results can be obtained by storing freshly cut seed pieces in ordinary burlap bags that have been moistened with water. Bags that previously contained fertilizer or salt should not be used unless thoroughly washed, as the chemicals may injure the seed pieces. When the moistened bags of seed are kept in a closed building, the humidity is generally high enough for proper suberization at 60° to 70° F. If storage conditions favor rapid evaporation, the bags should be sprinkled with water occasionally, or the piles should be covered with moist empty bags. The purpose is to provide enough moisture to create a humid atmosphere during the suberization period but not to keep the seed pieces very wet. The bags of seed should be piled in such a way that air can circulate among them. Under ideal conditions a protective layer of cork cells ordinarily develops within 48 hours. After 24 hours the bags should be turned over, in order to prevent cut surfaces of the seed from sticking together.

BREAKING THE REST PERIOD

The southern potato grower sometimes finds it necessary to plant his crop at a time when the available seed, shipped in from the North, has not yet passed through the whole of the rest period that follows digging. If he plants such seed it will not sprout normally, even under moisture and temperature conditions that ordinarily bring about sprouting, but will re-

main dormant in the soil until its rest period has been completed. The length of the rest period differs among varieties and is affected by the temperature at which the seed is stored. Ordinarily, potatoes remain dormant for a total of from 8 to 10 weeks.

The rest period can be shortened, or broken, by treating the seed with a solution of any one of several chemicals. The chemicals most commonly used for this purpose are ethylene chlorohydrin and ammonium thiocyanate.

Seed potatoes that are to be treated with a solution of ethylene chlorohydrin should first be cut into seed pieces and given 1 or 2 days for healing under the conditions just described. For potatoes that are treated less than 6 weeks after being dug, a solution of 1 gallon of anhydrous (concentrated) ethylene chlorohydrin in 75 gallons of water is recommended. A solution half this strong can be used for potatoes that have been out of the ground for 6 weeks or longer. If 40-percent ethylene chlorohydrin is used, a ratio of 1 part chemical to 30 parts water is recommended for treating freshly dug seed and a 1-to-60 solution for seed that has passed through a part of the dormancy period. The seed pieces are placed in slat boxes or burlap bags, lowered into the solution, and left in it long enough for each piece to be wet thoroughly. Excess solution is then drained off and the boxes or bags of treated seed are stacked loosely and left to dry for from 8 to 16 hours. If treated in late afternoon, the seed pieces dry sufficiently overnight to be planted the next day and are less liable to losses from rot than they would have been if dried at the higher temperatures of daytime.

If ethylene chlorohydrin is not available, either ammonium thiocyanate, potassium thiocyanate, or sodium thiocyanate can be used instead. Cut seed does not have to heal over before being treated with any of these chemicals. Soak the freshly cut seed pieces in a 1½-percent solution of the chemical for 1½ hours. The seed can then be planted in moist soil immediately. To increase the effectiveness of the treatment, make cuts through the bud end and one or more eyes of each tuber while cutting the seed pieces.

Potassium thiocyanate and sodium thiocyanate solutions are very poisonous. Avoid getting any of the solution into your mouth. Do not leave treated potatoes where animals will have access to them or where they may accidentally be mixed with untreated potatoes. All vessels used in the treatment should be thoroughly cleaned afterward. Dispose of old solutions so that humans and animals cannot get at them. Ethylene chlorohydrin gas is explosive in certain air mixtures; keep flame away from any room or bins where it is being used. Thoroughly ventilate the room before letting anyone enter.

PLANTING

The correct row width to be used in planting potatoes and the correct spacing for seed pieces within the row depend largely on the variety grown, the fertility of the soil, and the soil moisture available. Most commonly, southern potato growers space their rows 34 to 36 inches apart and their seed pieces 9 to 14 inches apart in the row. For very early potatoes, the distance between rows is generally 30 inches. In growing Kennebec and some other varieties under irrigation, close spacing is necessary to prevent the tubers from becoming too large. Usually close spacing helps to produce maximum yields under irrigation and also to prevent growth cracks and hollow heart. Potatoes

interplanted with sugarcane in Louisiana are grown in rows 6 feet apart.

The seed pieces are usually planted 3 to 5 inches deep, or at such depth that the tubers will be covered with moist soil at all times (fig. 2). A late crop should be planted deeper than an early one, and in light soil the seed should be planted deeper than in a heavy soil. Shallow planting produces small tubers in dry seasons, and in favorable seasons some of the tubers in shallow-planted hills are likely to push out of the soil and become sunburned.

Commercial potato growers of the South generally do their planting with machines, either horse-drawn or tractor-drawn. They use machine planters of the picker type, the cup type, and the assisted-feed type. The picker planter is highly automatic, requires very little hand checking, and costs little to operate. It gives good results if the seed pieces have been cut blocky and reasonably uniform in size; otherwise, it is likely to miss some spaces and plant double in others. The cup planter, operated by 1 or 2 men, is especially suitable for planting whole seed. The assisted-feed machine plants more slowly and requires 2 men, but it usually spaces seed more accurately than the picker planter.

In hand planting, limited to gardens and other small acreages, the seed pieces are usually dropped in an open furrow and covered with a turnplow or hilling disk.

The average quantity of seed potatoes used in planting an acre, according to weight of seed pieces, distance between rows, and spacing within the row, is shown in table 1.

VINE KILLING

In the South the practice of killing potato vines before harvest has not yet become widespread but is increasing. Killing the vines makes digging easier, helps to prevent late blight infection from spreading to the tubers, and tough-

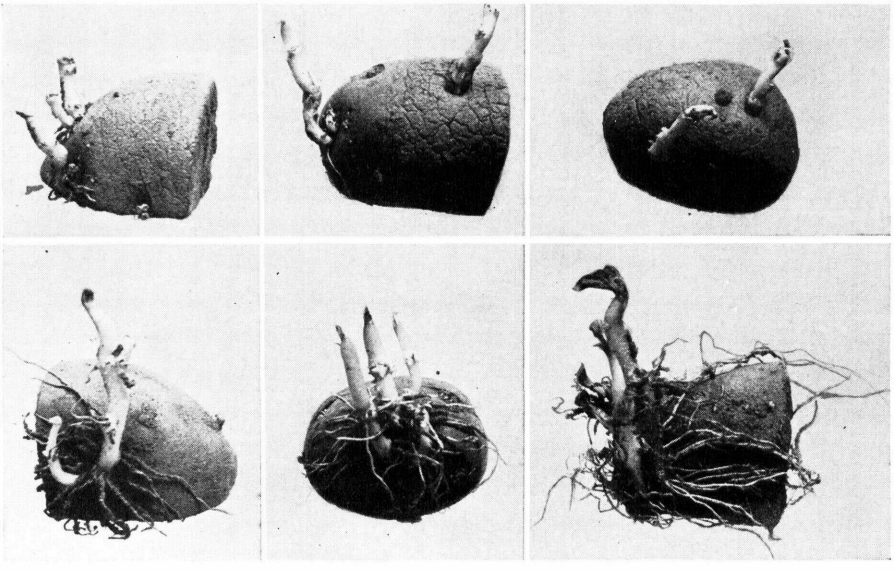

FIGURE 2.—The seed pieces in the upper row sprouted in dry soil; those in the lower row, which were planted the same day, sprouted in moist soil. Note the difference in root formation.

TABLE 1.—*Average quantity of potatoes required to plant an acre with seed pieces, according to weight of pieces and spacing*

Space between rows (inches)	Space between seed pieces (inches)	Potatoes required to plant an acre if weight of pieces averages—				
		1 ounce	1¼ ounces	1½ ounces	1¾ ounces	2 ounces
		Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*
30	9	24. 2	30. 3	36. 3	42. 3	48. 4
	10	21. 8	27. 3	32. 6	38. 1	43. 6
	12	18. 2	22. 7	27. 2	31. 8	36. 3
	14	15. 6	19. 4	23. 3	27. 2	31. 1
	16	13. 6	17. 0	20. 4	23. 8	27. 2
32	9	22. 7	28. 4	34. 0	39. 7	45. 4
	10	20. 4	25. 5	30. 6	35. 7	40. 8
	12	17. 0	21. 3	25. 6	29. 8	34. 0
	14	14. 6	18. 2	21. 9	25. 5	29. 2
	16	12. 8	16. 0	19. 2	22. 4	25. 6
34	9	21. 4	26. 7	32. 0	37. 3	42. 8
	10	19. 2	24. 0	28. 8	33. 6	38. 4
	12	16. 0	20. 0	24. 0	28. 0	32. 0
	14	13. 7	17. 1	20. 6	24. 0	27. 4
	16	12. 0	15. 0	18. 0	21. 0	24. 0
36	9	20. 2	25. 2	30. 3	35. 3	40. 3
	10	18. 1	22. 7	27. 2	31. 7	36. 3
	12	15. 1	18. 9	22. 7	26. 5	30. 2
	14	13. 0	16. 2	19. 4	22. 7	25. 9
	16	11. 3	14. 2	17. 0	19. 8	22. 7

ens the skin of the tubers, making them less liable to injury. Also, it helps the grower to time his digging so as to take full advantage of favorable market conditions and availability of labor. The means now used for killing potato vines include chemical spray solutions, mechanical beaters, and oil-burning flame throwers.

Sprays made from Dowspray 66, improved (dinitro ortho secondary butyl phenol), Sinox General (dinitro ortho secondary amyl phenol), or Handy Killer (sodium arsenite) kill potato vines very effectively. The manufacturer's directions for preparing each particular spray should be followed carefully.

The mechanical beater (fig. 3) has many low-hanging rubber flails, which revolve at high speed in a plane perpendicular to the surface of the ground and thus completely shred the vines. The shredded vines are thrown forward and upward against the cover of the machine and then fall to the ground.

An oil-burning flame thrower generally checks the growth of potato vines the first time it is used and kills them when used again.

In southern Florida, where killing potato vines before harvest is a common practice, the vines are usually sprayed with a solution of two-thirds pint of Sinox in 100 gallons of water. This spray causes the vines to turn brown. A few days later, the killing is completed with a mechanical beater.

The method just described causes practically no stem-end discoloration in the tubers. Other methods of vine killing—with chemicals, mechanical beaters, and flame throwers—may cause considerable stem-end discoloration of tubers, especially if the soil is dry at the time. The greatest discoloration is caused by the chemical vine killers that act the quickest.

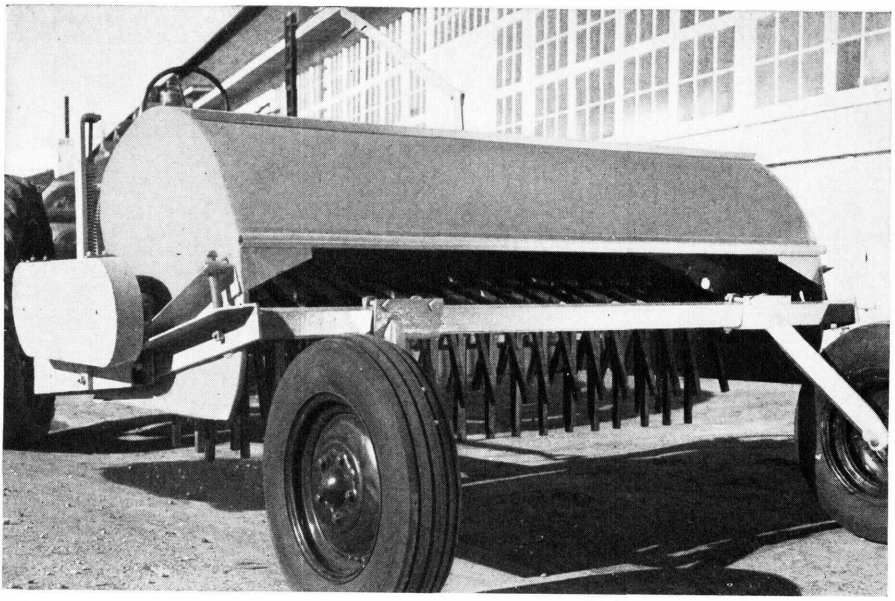

FIGURE 3.—Beater machine for killing potato vines, thus making it easier to dig and pick the crop. Revolving flails reduce the vines to shreds.

HARVESTING

Injuries to potatoes during the digging operation lead to considerable losses from rot and other causes. This is especially true of early potatoes, the principal potato crop in the South, because they are usually immature when harvested. To help reduce these losses, potato-digging machinery has been considerably improved in recent years. The present-day wide, low digger with only one chain, for example, causes much less injury to the tubers than earlier types with two chains.

In a recent study on marketing of early potatoes, about 9 percent, by weight, of the potatoes in samples from some of the commercial potato-growing areas in the South were found to have cuts and bruises. Most of the injuries were minor ones caused by the wire baskets used as pickup containers (fig. 4). Use of wooden hampers led to similar although less frequent and less severe injury. The results of the study indicate that most of the injuries caused in picking up potatoes can be prevented by using baskets made of rubber-coated wire. On an average, in this particular study, use of baskets made of rubber-coated wire resulted in injuries to about 3 pounds of potatoes per 100-pound total, compared with 6 pounds for the wooden hampers and 12 pounds for uncoated-wire baskets.

Some losses always result from cuts made by the digger blade. Under present grading standards only a small percentage of the digger injuries other than cuts are

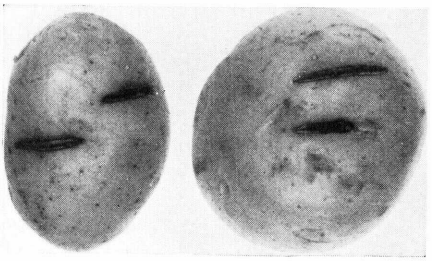

FIGURE 4.—Typical injuries to potatoes caused by using pickup baskets of uncoated wire.

classified as grade defects. However, these injuries should be avoided as much as possible. They often cause spoilage in transit when temperatures are high, and even if they heal over they leave scars that give the potatoes an unattractive appearance and increase peeling waste. While potatoes are being run over a grader, or sizer, the speed of the grader should be regulated so as to avoid unnecessary skinning, and padding should be used wherever needed to prevent bruising. Injuries are reduced somewhat by letting potatoes cure in the shade for 24 hours before grading them.

WASHING AND STORAGE

Washing potatoes before shipping them is common practice in most of the important potato-producing areas of the South. This improves the appearance of the tubers, especially if they are of a red variety, and makes grading easier.

In the past it was customary to run the potatoes through a soaking tank and then through a rinsing spray. Such washing generally left a considerable percentage of the tubers infected with a soft rot organism. The rot organism entered the tank water in soil clinging to tubers, and readily entered tubers in the water through bruises in their tender skin. Spraying jets have now largely replaced the soaking tank, and this change has helped to reduce rot infection. Some rot still occurs, however, for the washing does not remove all soil particles infected with rot organisms.

From the washer, the potatoes are carried on a conveyor-belt system to a grader and then past sorters, who remove all decayed or otherwise undesirable tubers. Although the potatoes are still more or less wet when packed, they generally arrive at market in excellent condition if they were washed and loaded during periods when the relative humidity of the air was low. It is considered unsafe to ship washed potatoes immediately, without drying them, if the relative humidity of the air is above 70 percent. Under those conditions, the potatoes are likely to decay badly before reaching their destination.

In experiments conducted by the Subtropical Experiment Station at Homestead, Fla., washed potatoes were cooled before shipment, by a method that involves withdrawal of moisture from the air and rapid movement of cold, dry air through the load. The treatment proved fairly effective in preventing washed potatoes from decaying in transit, probably more because of its drying than because of its cooling effect.

Drying potatoes with a large electric fan definitely reduces soft rot, but the rapidity and thoroughness of fan drying are limited by air temperature, relative humidity, size of tubers, and other factors.

Experiments in drying potatoes with heated air were begun in Florida in 1936. Heating air increases its capacity to absorb and hold moisture. Potatoes were not damaged when dried for 4 minutes in air heated to 150° F., and bacterial soft rot did not develop in them.

The first commercial hot-air potato drier in the South was installed in a packinghouse at Goulds, Fla., in 1938. The second, of larger capacity and different design, was installed in another packinghouse at Goulds at the beginning of the 1939 shipping season and has given exceptionally satisfactory results. A slightly modified form of the second experimental drier is now generally used in Florida. Essentially it is an insulated chamber containing about 100 feet of roller conveyor, on 3 levels, and supplied by oil-burning furnaces with

heated air, which is forced through the chamber by means of blower fans. The speed of the conveyor allows the potatoes approximately 4 minutes of exposure to the heated air, which moves in the direction opposite to that in which the potatoes move. Air temperature is automatically adjusted to wide and frequent variations in relative humidity. When the drier is properly adjusted the temperature of the tubers increases little or not at all, because of the cooling effect of evaporation.

Experiments conducted in Louisiana have shown that sweetpotato storage houses can be used satisfactorily for storing Irish potatoes, especially if fans are used and ventilators are kept open during the night and closed during the heat of the day. In one test, potatoes dug in May and stored under these conditions were still marketable on September 1, although they had developed small sprouts. Information now available does not justify recommending chemical treatment to prevent sprouting under southern conditions.

At the higher elevations in North Carolina, Georgia, and Tennessee, potatoes are stored about as recommended for the North in Farmers' Bulletin 1986, Potato Storage.

POTATO GROWING IN INDIVIDUAL STATES

Outstanding features of potato growing in 12 of the Southern States are briefly outlined here. More detailed information can be obtained from State agricultural colleges, agricultural extension services, and county agents.

ALABAMA

Potatoes are grown on a large scale in southwestern Alabama, in a district of about 25,000 acres including Baldwin, Mobile, and Escambia Counties. Here Triumph and Sebago are the leading varieties. The spring crop is planted between February 1 and March 15. Harvesting of spring potatoes begins about April 10 and ends about June 1. Fall potatoes are grown on about 1,500 acres and are dug in late December.

Late blight and blackleg are the most serious potato diseases in southwestern Alabama. Nearness to the Gulf coast and regular night dews provide ideal conditions for development of late blight. The potato growers spray regularly for blight control.

Potatoes grown in southwestern Alabama are washed before being shipped.

FLORIDA

The principal potato-growing districts of Florida center around Hastings, Homestead, Belle Glade, and Fort Meyers.

In the Hastings district, potato plantings of the year 1952 totaled about 16,000 acres. Here the first planting begins the middle of January and harvesting of the spring crop begins in April. At least 95 percent of the potato acreage is planted to Sebago; other varieties grown include Red Pontiac, Irish Cobbler, Red Warba, Kennebec, and Cherokee.

In the Homestead district, about 8,000 acres of land is planted to potatoes, largely to the Pontiac variety. Planting begins in November. The harvest season extends from January to April. At digging time the vines, still green, are killed by applying Sinox at the rate of two-thirds pint per acre and shredding them a week later with a rotobeater.

At Belle Glade, about 1,500 acres of potatoes are planted in January and harvested in April and about the same acreage is planted in Oc-

tober and harvested in December. Sebago is used as the spring crop and a red variety, most commonly Triumph, as the fall crop. Limited tests of La Soda have given very satisfactory results.

Before planting northern seed in Florida in early fall, it is necessary to treat the immature seed (seed that has had less than 6 weeks of storage) to hasten sprouting. This is done with ethylene chlorohydrin by methods described on page 9.

Florida growers usually spray their potato fields for control of late blight. In the southern part of the State, not uncommonly they spray at weekly intervals.

Florida potatoes are always washed before being shipped. Usually, after being washed they are passed through a drier.

GEORGIA

Most of Georgia's early potato crop is grown on about 650 acres of land in coastal Chatham County, near Savannah. Katahdins make up about 80 percent of the early crop, Pontiacs and Triumphs about 20 percent. The crop is dusted with copper for control of early blight and late blight. It is dug between May 1 and the middle of June.

In the State's mountain section Sequoia, Irish Cobbler, and Kennebec are grown and are harvested about August 1.

KENTUCKY

In Kentucky potatoes are grown, mostly as a spring crop, on about 3,200 acres of land nearly all of which is within the Louisville district. Irish Cobbler is planted mostly as an early crop. The fall crop is grown on about 1,000 acres of land and consists mainly of Irish Cobbler, Katahdin, and Sequoia. Recently Kennebec has been added to the fall varieties.

Early blight affects the crop generally, at about the time of maturity. Late blight appears occasionally. It became epidemic in 1950, causing loss of about 60 percent of the total crop. Only a few growers make a regular practice of spraying with fungicides. They use nabam (Dithane Z–78) and, to a limited extent, copper oxide.

LOUISIANA

In Louisiana, practically all the potatoes grown are planted as an early crop. Lack of moisture at the time of fall planting results in very low winter yields. Early-crop planting begins about January 1 and continues till early March. Harvesting begins in late April and ends in early June. The important potato-growing districts are Point Coupee, Lafourche, Terrebonne, St. James, West Feliciana, and West Baton Rouge.

Triumph has been grown almost exclusively, but since 1952 La Soda has become very popular because of its rather heavy yield and its tendency to recover rapidly from ill effects of frost or drought.

Complete and near failures of potato crops due to epidemics of late blight in 1945 and 1947 have caused Louisiana farmers to make great reductions in their potato acreages. Some of the larger growers have now equipped themselves for regular spraying. Small growers prefer to stop planting potatoes rather than go to the expense of buying sprayers or face the risk of crop failure due to blight. A blight-resistant red variety is very much needed. Early blight occurs commonly in unsprayed fields, but it develops only when the plants mature and, therefore, has no great importance.

Practically all the large growers wash their potatoes before shipping them.

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MARYLAND

Potatoes are grown extensively on the lower Eastern Shore of Maryland, in the counties of Worcester, Wicomico, and Somerset. Here the farmers do their potato planting between March 15 and April 15 and harvest the crop in July. Maryland's other main potato-growing districts are in the State's three westernmost counties, Washington, Allegheny, and Garrett. The western Maryland growers plant in the first half of May and harvest between August 15 and October 15. The total area planted in the State is about 8,000 acres.

Irish Cobbler leads in popularity as a variety for early planting. Other varieties grown include Katahdin, Kennebec, Pontiac, Ontario, and Sebago.

The principal diseases affecting Maryland potatoes are late blight, early blight, scab, rhizoctonia, and wilts. Hopperburn sometimes causes serious losses. The growers maintain a regular program of spraying and dusting. They apply copper as bordeaux spray or in dust form and use nabam (Dithane Z–78) both as a spray and as a dust.

MISSISSIPPI

In Mississippi potatoes are grown commercially on about 1,000 acres of land and are grown for home use on areas totaling about 8,000 acres. The commercial acreage has declined greatly since 1945–46, when late blight caused disastrous losses. Commercial growers operate mainly in the Gulfport, Columbia, Wiggins, Hattiesburg, Laurel, and Jackson districts.

Triumph is the principal variety. Some Katahdins are grown, primarily to be marketed locally after 6 to 12 weeks of storage. Sweetpotato storage houses, otherwise empty in summer, are used for storing the Katahdins.

Sclerotinia rot and late blight are the most important diseases affecting the crop. Very few growers have equipment for spraying.

NORTH CAROLINA

In the eastern counties of North Carolina early potatoes, principally Irish Cobblers, Triumphs, and Katahdins, are planted from late January through February and are dug in June. In the western mountainous area, a late crop of Sequoias, Irish Cobblers, Katahdins, and Kennebecs is planted in late March or early April and is dug in August and September.

Brown rot (bacterial wilt) is one of the more serious diseases in the eastern part of the State. Late blight, fusarium wilt, and rhizoctonia canker sometimes cause serious losses in the western potato-growing districts.

Washing is practiced in many of the large eastern grading and packing sheds.

SOUTH CAROLINA

Commercial potato-growing areas in South Carolina make up a total of about 8,000 acres, most of which is in the lower part of the coastal plain. Charleston County produces more than half the commercial crop; the remainder comes from Beaufort, Horry, Jasper, and Colleton Counties.

South Carolina commercial growers plant the Sebago variety almost exclusively. Farmers who wish to market their crop early grow some Irish Cobblers, Triumphs, and Katahdins. Fall potatoes are not planted commercially; they are grown by a few home gardeners, usually with little success.

The most important of the field diseases are late blight, bacterial wilt (brown rot), and common scab. Late blight occurs occasionally; it has appeared several times in recent

years but has not caused extensive damage since 1945. Commercial growers practice dusting and spraying as a regular program.

Brown rot (bacterial wilt) and common scab are present in scattered fields over the entire potato-growing area. Diseases that affect potatoes during shipment, particularly soft rot and scald, cause more loss than all the field diseases combined. They result mostly from improper handling of the tubers at harvest.

TENNESSEE

In 1948 Tennessee farmers were growing potatoes on about 33,000 acres of land; but unfavorable weather conditions in recent years have reduced yields, and as a result this total has shrunk to about 18,000 acres.

The chief potato-growing counties are Franklin and Coffee. Others include Morgan, Cumberland, Union, Anderson, Carter, and Johnson. Sequoia, Irish Cobbler, Katahdin, and Kennebec lead among the varieties grown. Kennebec has performed exceptionally well, especially at the higher elevations. West Tennessee contains only one commercial potato-growing district—a small one near Memphis where Triumph is grown. No other district in the State favors a red variety.

Late blight is the most important disease in the higher elevated districts; scab and charcoal rot are found in most of the others. Commercial growers of upper east Tennessee, the Cumberland Plateau, and Franklin and Coffee Counties spray and dust fairly regularly to control disease, but very few of them achieve adequate control. Most commonly they use tribasic copper as a fungicide.

TEXAS

Practically all the Texas potato acreages in the Rio Grande Valley, in the district near San Antonio, and in the panhandle are irrigated land. Ordinarily, these three districts comprise about 80 percent of the State's commercial potato acreage and 45 percent of its total potato acreage. Potato lands in the State as a whole total about 13,500 acres, and their yield averages about 100 bushels per acre.

Texas growers plant the Triumph variety almost exclusively. Recent limited plantings of La Soda have given encouraging results. Irish Cobbler and White Rose are planted to some extent in the panhandle. Sprays are used on about 80 percent of the crop, mostly for control of late blight.

All commercially produced potatoes of the spring crop are washed, and some are waxed.

VIRGINIA

Virginia's 22 eastern counties produce the bulk of the State's commercial potato crop. They include Accomac and Northampton Counties, located on the Delmarva Peninsula, and a part of the tidewater section of the mainland. Beyond the tidewater area, Virginia produces very few potatoes commercially.

In 1952 potatoes were grown on 24,000 acres of Virginia land, and the yield totaled 4,000,000 bushels. Areas planted for fall harvest amounted to not more than 2,500 acres. The varieties most commonly grown are Irish Cobbler, Chippewa, Katahdin, Sequoia, and Kennebec.

Early blight, late blight, and scab are the most important diseases. For control of blights the commercial growers practice regular spraying and dusting with soluble and insoluble coppers.

DISEASES AND THEIR CONTROL

The potato is subject to many diseases caused by bacteria, fungi, and viruses and to other diseases caused by unfavorable growing conditions. The extent and seriousness of diseases caused by organisms and viruses vary according to the weather and to the nature and condition of the soil in which the crop is grown. A warm rainy period following a cool spell favors late blight. The condition of the soil, its acidity or alkalinity, and its moisture content determine the prevalence of such diseases as blackleg, wilt, and scab.

Ordinarily, if wilt or one of the other diseases that result from planting infected seed appears in potatoes being grown for table stock, the grower does not try to control it. Northern growers of potato seed do control these diseases. The fact that certified seed potatoes are relatively free of infection is the reason why most commercial growers prefer to plant certified seed only.

Seed potatoes that are to be used for planting new land or other land

FIGURE 5.—Potato tubers showing blackleg infection.

not heavily infested with organisms causing potato diseases should generally be disinfected as described on pages 6 and 7. Methods of spraying and dusting for control of potato diseases are discussed on pages 31–33.

The principal diseases affecting potatoes in the South are described here, and methods for controlling them are discussed.

BACTERIAL DISEASES

Blackleg

Blackleg, caused by *Erwinia atroseptica*, is the most common bacterial disease of the potato. It has been responsible for heavy crop losses in some southern potato-growing areas. It also causes serious rotting of the tubers in storage (fig. 5).

In the field, the first symptoms are rolling and yellowing of the upper leaves of one or more shoots. The plant wilts and dies. In advanced stages of the disease, inky-black lesions develop, sometimes extending 6 to 12 inches upward in the stem and also extending downward through the stolons into the developing tubers, in which soft rot may start at the stem end. Affected tubers decay rapidly in wet soil.

The bacterium causing blackleg may be carried in healthy-looking seed from infected plants and may be spread by seed-corn maggots. Also, if present in the soil it may enter potato seed that has been freshly cut and planted under conditions unfavorable for the formation of a corky layer over the cut surfaces.

Control

Tubers showing signs of blackleg should not be planted. Care should be taken also to prevent rot from developing in seed before it is planted, because seed pieces having decayed spots may be destroyed by blackleg after they are planted. Healthy whole seed should be used, or cut seed corked over well enough to prevent soil infection.

Soft Rot

Bacterial soft rot, now considered to be caused by a strain of the blackleg organism, *Erwinia atroseptica*, is another of the major potato diseases in the South. In the field, soft rot occasionally causes serious losses of seed pieces, and if the soil becomes waterlogged may cause decay of newly formed tubers (fig. 6). The greatest losses from soft rot, however, occur during storage and transit.

The soft rot organism is normally found in the soil. Its growth and activity there depend largely upon the supply of soil moisture. Fresh breaks or cracks in the skin of potato tubers make it easy for the soft rot organism to enter. The disease is favored by rainy weather, when potato tissues are moist and the lenticels (breathing pores) enlarge, providing an avenue of entrance for the bacteria. The infection may spread by contact from decayed to healthy tubers when potatoes are packed or piled together.

If the tubers have decayed in moist air, the affected tissue is white or cream colored, soft, and somewhat watery, and usually a clear amber-colored liquid exudes from it. In dry air, decayed tissues lose their soft consistency. Complete drying may reduce them to grayish-white chalky masses. Bacterial soft rot in advanced stages is usually attended by foul, nauseating odors caused by secondary disease organisms.

Control

The first rule for controlling soft rot is to handle the potato crop carefully during harvest so as to avoid unnecessary wounds, cuts, cracks, or bruises and avoid sunscald. Potatoes should be harvested in dry weather, to promote rapid

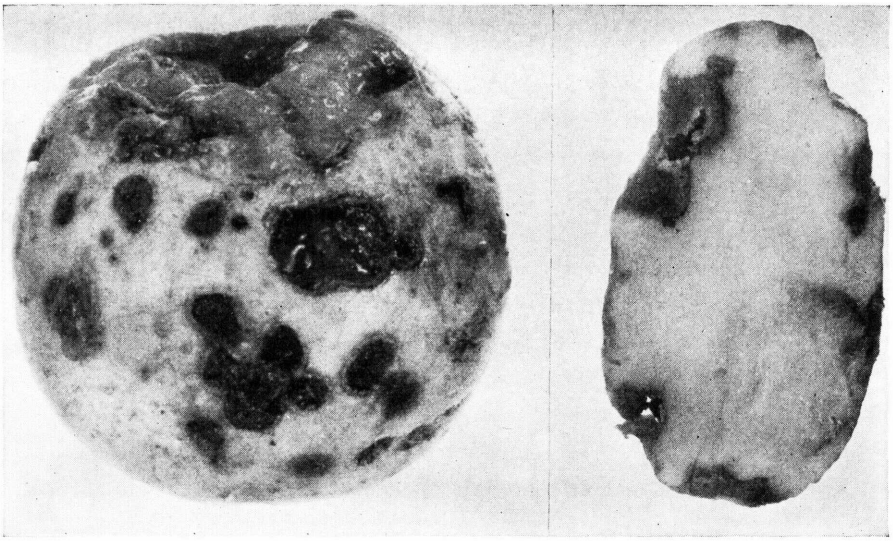

FIGURE 6.—Soft rot of potato as it appears on the outside and in a section of a tuber. (Courtesy of Florida Agricultural Experiment Station.)

drying and healing of wounds. If tubers are washed, spray jets should be used rather than soaking tanks. Washed tubers should be dried rapidly. (Washing of potatoes is discussed on p. 13).

Brown Rot (Bacterial Wilt)

Brown rot (known also as bacterial wilt and southern bacterial wilt) is caused by *Xanthomonas solanacearum*, which attacks not only potatoes but tomatoes, eggplant, peppers, and many other plants that grow in the South. Brown rot is present in the South Atlantic States and Gulf Coast States, from Maryland to Texas, and in Kentucky. For reasons of climate, it does not occur elsewhere in the South.

Brown rot may cause a great reduction in potato yield if the plants become infected at an early stage of growth. The disease is important in parts of North Carolina and especially in Florida. In the Hastings district of Florida it caused serious losses until the susceptible variety Spaulding Rose was replaced by the somewhat resistant varieties Sebago and Katahdin. The disease can be serious in sandy, sandy loam, clay, muck, and peat soils. It has never been found in potatoes growing in the marl soils near Homestead, Fla. The greatest losses from brown rot occur when temperatures are above normal during the latter half of the growing season.

Brown rot is sometimes very severe in the first crop of potatoes grown on newly cleared land. During very warm seasons it can cause losses in fields that have been under cultivation for a long time, but it is generally less troublesome in such fields. The disease varies in severity among different parts of a field; sometimes it is confined to low spots and sometimes almost entirely to high, dry places.

Brown rot bacteria are spread from place to place on soil particles blown by wind and in drainage water. They may be spread also in soil carried on machinery and on the feet of animals used in cultivating.

The first symptom of the disease is a slight wilting of the leaves at

the ends of branches during the hottest part of the day. For a time the plant recovers during the night, but the wilting becomes more pronounced each day. Roots, stolons, parts of the stem below the soil surface, and several inches of stem above the surface turn brown. Complete wilting and death follow the cutting off of the plant's water supply. The bacteria form a white mass. When affected parts are cut or broken, bacteria ooze from them.

The outside of an affected tuber may or may not show signs of brown rot, depending upon the stage of development of the disease when the tuber was dug. Bacteria ooze from eyes and stem end of a severely diseased tuber and become mixed with soil, and the mixture dries on the surface of the tuber and sticks there (fig. 7). In advanced stages the brown color of affected parts can be seen at the surface of the tuber, particularly around the eyes and at the stem end. After brown rot bacteria destroy the vascular ring and its surrounding tissue and break through the skin, other disease organisms enter and the tuber becomes a slimy mass with an offensive odor.

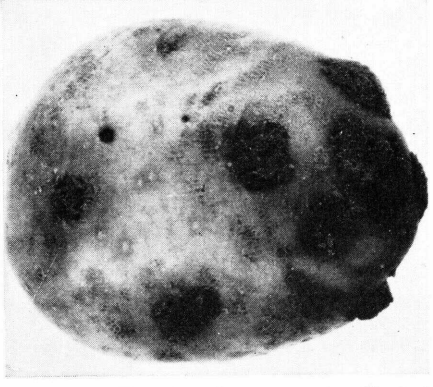

FIGURE 7.—Potato tuber severely affected with brown rot. Bacteria have oozed from some of the eyes, and a dried mixture of bacteria and soil is sticking to these eyes. (Courtesy of Florida Agricultural Experiment Station.)

Control

The Sebago and Katahdin varieties are much more resistant to brown rot than Spaulding Rose, Irish Cobbler, or Bliss Triumph. The infection is usually not carried in seed potatoes used in the South, because it is not present in the localities where they are generally produced. Since many weeds are susceptible to brown rot, this disease cannot be eliminated from infested land by crop rotation.

Ring Rot

Ring rot, caused by *Corynebacterium sepedonicum*, is a very infectious bacterial disease. It has been known to occur in this country only since about 1934, but it is now present in nearly all the potato-growing States. The disease caused severe losses before understanding of its nature became sufficient to make control possible. Since the causal bacterium does not live over winter in the soil but is carried over only in infected potatoes, the practice of planting healthy certified seed potatoes has greatly reduced the losses from this disease. Under the strict regulations of the seed-potato industry, a single infected plant found in a potato field disqualifies the whole field for certified-seed production. In spite of precautions some infected plants escape notice, so that even in certified potato seed a few tubers infested with ring rot are occasionally present.

Ring rot is so infectious that a knife used to cut an infected tuber may infect 20 pieces cut immediately afterward.

Symptoms of ring rot usually do not appear until the potato plants are nearly full grown. Some infected plants do not show any symptoms; in others, while one or a few stems in a hill may wilt and become more or less stunted, the remainder may appear healthy. Ordinarily,

the areas between the veins of some of the lower leaves on the infected stems turn pale yellow, and within a few days these areas develop a more pronounced yellowing or die and the leaf margins roll upward. Leaf discoloration is accompanied by a progressive wilting, which continues until all the leaves on a stem have wilted. After that the stem soon dies. If the stem of a plant in an advanced stage of the disease is cut across at the base and squeezed, a creamy fluid flows out. Infection of the tuber takes place at the stem end and progresses through the vascular tissue. A cut at the stem end of an infected tuber reveals tissue of a cheesy appearance, which is creamy yellow or light brown in the region of the vascular ring (fig. 8). When pressure is applied to a tuber in an advanced stage of infection, the tissue outside the vascular ring definitely separates from the tissue inside. In addition, tubers severely affected with soft rot that have been invaded by other disease-causing organisms may show external cracking and browning of the skin.

Control

The one way to control ring rot is to use no seed potatoes infected with the bacterium that causes it. This necessitates making sure that sorters or graders and picker planters used are not contaminated. A potato storage place in which ring rot was present in stored potatoes during the previous season should be disinfected with a solution of copper sulfate prepared at the rate of 1 pound of the chemical to 10 gallons of water. Containers and other equipment, such as baskets, crates, bags, barrels, graders, knives, gloves, and planters, that have been in contact with potatoes infected with the bacterium must be disinfected before they are used for uninfected seed potatoes. By taking

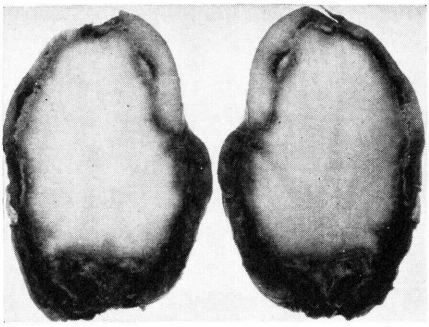

FIGURE 8.—Lengthwise slicing of this tuber revealed that ring rot had separated the outer layer of tissue. (Courtesy of Florida Agricultural Experiment Station.)

the sanitary measures mentioned, some seed-potato growers have succeeded in eradicating ring rot from their farms.

FUNGUS DISEASES

Common Scab

Common scab, caused by a soil organism called *Streptomyces scabies*, exists in every potato-growing section of the United States. The disease is confined entirely to the tubers. Usually the lesions are small and brownish at first; later they may become large and very corky (fig. 9). Frequently they extend below the tuber surface and removing them leaves deep pits. Such lesions are known as pitted scab. Sometimes the lesions appear as small russeted areas, which may be so numerous that they almost cover the tuber surface, and sometimes they are slight protuberances with depressed centers. The surface lesions are covered with a thin layer of corky tissue.

Injuries that resemble the first stages of common scab in outward appearance are sometimes caused by larvae of the potato flea beetle.

Common scab may be very mild in soil in which it was very severe the preceding season. Temperature,

moisture, soil aeration, and soil reaction (pH)[2] are all important factors in the development of scab. The disease may be severe in alkaline or mildly acid soils. It causes little or no damage in strongly acid soils. Fresh manure should not be added to soil just before plowing for potatoes, as it seems to stimulate scab development. Applications of lime or wood ashes tend to bring about an alkaline soil condition favoring scab development. Ordinarily, common scab develops most when soil moisture is slightly below the requirement for optimum growth of the potato plant. On the other hand, very severe scab may develop in peat soils that are wet through most of the growing season.

A high percentage of scabby tubers in a field generally means that high temperatures occurred frequently when the tubers were newly formed. Scab is relatively mild and infrequent on potatoes planted during the winter months or in very early spring.

Control

Scab can be successfully controlled by means of various seed treatments (see pp. 6–7), unless the seed is planted in scab-infested soil. The scab organism can live in the soil for a long time. If the soil is infested, use of clean or disinfected seed will be of little value in preventing scab from developing on the new tubers.

Heavily scabbed potatoes should not be planted on clean land, at least without first being thoroughly disinfected. If lightly scabbed seed potatoes are planted in soil acid enough to be unfavorable for growth of the scab organism (that is, having a pH of less than 5.2), scab generally does not develop in the tubers grown.

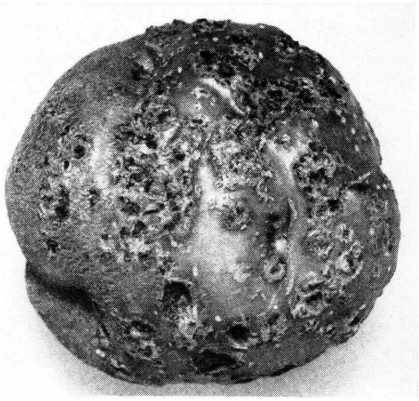

FIGURE 9.—A potato tuber severely affected with common scab.

Land that has produced a crop of potatoes badly infected with the organism causing scab should be used for growing other crops for several years, to help reduce the infestation. No practical soil treatment has been developed that can be depended on to eliminate this organism. Finely divided sulfur applied to the soil at the rate of 500 pounds per acre sometimes helps to reduce scab infection of potatoes, but generally it is doubtful that soil treatment to prevent scab can be justified.

Scab-resistant varieties appear to give more hope than anything else for successfully growing potatoes on scab-infested land. Commercial varieties highly resistant to common scab include Menominee, Ontario, Cayuga, Seneca, and Cherokee. These varieties are not ideally suited to southern growing conditions, but all of them—particularly, Menominee and Cherokee—will produce satisfactory crops on land where susceptible varieties cannot be grown on account of severe scab infestation.

[2] The pH value is commonly used to express degree of soil acidity or alkalinity. A neutral soil has a pH value of 7. Values above 7 denote alkalinity; values below 7, acidity. A soil with a pH value of 6 is mildly acid, one with a pH value of 5 is strongly acid, and one with a pH value of 4 is very strongly acid.

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Rhizoctonia Canker (Black Scurf)

Rhizoctonia canker, caused by the fungus *Rhizoctonia solani*, is found in practically every potato-growing section of the South, as of other regions of this country.

In rhizoctonia, cankers may develop on the stolons and cut the tubers off from the main stem, thus preventing them from making any further development. Cankers occasionally develop on the stems of other plants, but without extending so deep into the stems as to destroy the parts above. The stem cankers appear as irregular, elongated brown areas at or below the surface of the soil (fig. 10). Such cankers interfere with the movement of plant food material to the roots and tubers, and thus prevent their normal development. The vines of a cankered plant become yellow or reddish yellow. The leaves tend to roll, because food material accumulates above the canker; the stalks become swollen, especially at the nodes; and the buds enlarge, sometimes forming small aerial tubers.

Some sprouts of a seed piece may be completely destroyed by the *Rhizoctonia* fungus before they reach the surface of the soil. Sprouts that have been only partly destroyed may develop new growth.

The skin of infected tubers may become russeted, either in patches or entirely. In this case the disease is sometimes referred to as russet scab. The fungus produces some small brown-black bodies that stick closely to the skin of the tuber. These bodies, called sclerotia, are compact mats of mycelial threads, the resting stage of the fungus. They may be as small as a pinhead or half as large as a pea. When introduced into the soil on potato seed, the sclerotia produce abundant fungus threads that attack the young shoots, stolons, and tubers of the new crop. The fungus can live in plant residues in the soil for a long time.

Although the greatest injury to potato sprouts from *Rhizoctonia* occurs at temperatures below 70° F., lesions may be produced at any temperature from 48° to 80° if other conditions are favorable for growth of the fungus.

Control

The fact that *Rhizoctonia* can live over in the soil and its sclerotia can survive on the tuber surface must be considered in undertaking control measures. Crop rotation alone is not effective in eradicating the fungus, because weeds and many cultivated plants besides potatoes are susceptible. The best method of control now available is to plant only tubers free from the infection or treat affected seed tubers with mercuric chloride or another disinfectant (see pp. 6–7) and practice crop rotation.

Southern Blight

Southern blight, or sclerotium rot, caused by the fungus *Sclerotium rolfsii*, is a disease of minor importance found in practically all vegetable crops and many weeds in the Southern States.

The fungus lives both in dead plant material in the soil and in living plants. It forms sclerotia about the size and color of mustard seed. Under favorable conditions the sclerotia germinate, forming tiny threadlike strands, which penetrate potato stems, seed pieces, and tubers (fig. 11).

The southern blight fungus attacks most frequently at the surface of the ground. During the heat of the day young leaves affected by it wilt, but in an early stage of the disease they recover at night. As wilting progresses, the foliage turns yellow and the leaves fail to recover. After this the leaves die, the stems lose their color, and the entire plant dries out and dies. At the base of an affected stem sunken discolored

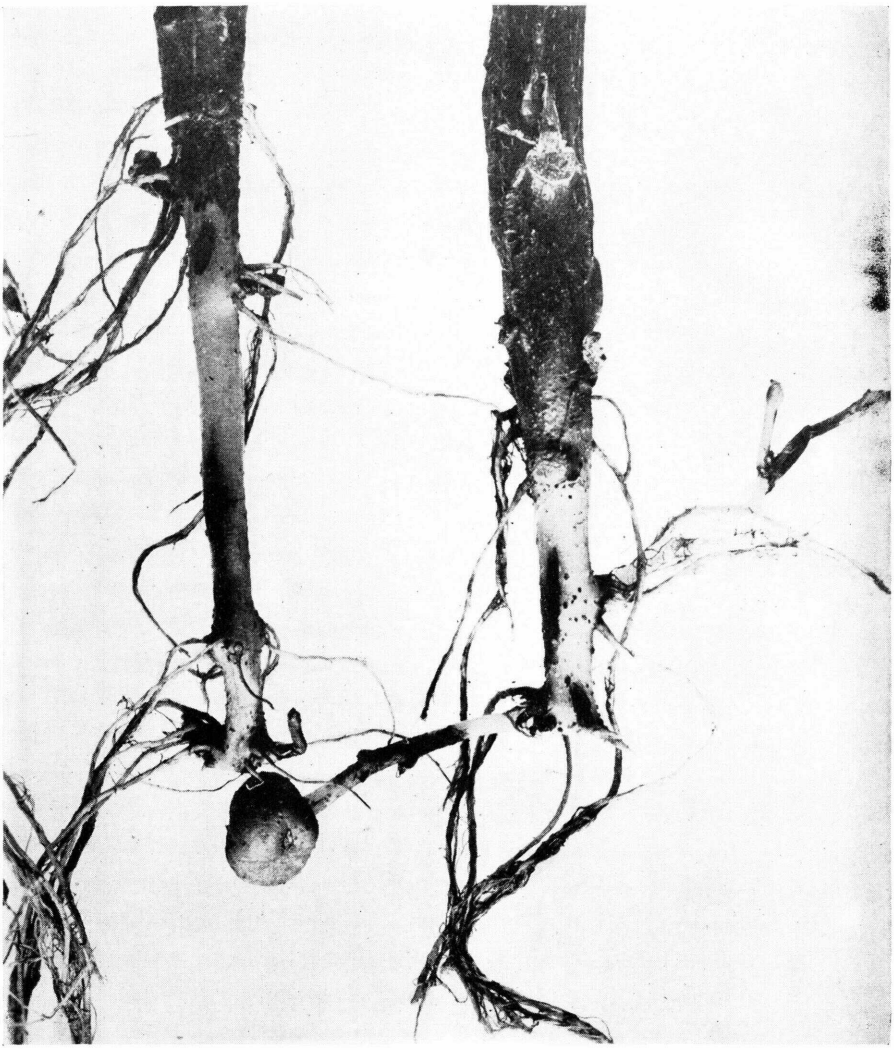

FIGURE 10.—Potato stalks, roots, and stolons showing dead areas due to infection with *Rhizoctonia solani*.

areas are produced, usually just below the surface of the ground. The outer part of the stem decays first. Under slight pressure, the decayed part sloughs off. When the stem has completely decayed, the plant dies. In seed pieces and tubers the disease takes the form of a soft rot; after other disease organisms enter a tuber, the decaying tissue finally turns brown or black. Southern blight of potato tubers causes rapid and complete decay in wet soil but develops slowly in dry soil.

Control

Since the southern blight fungus is soilborne and attacks a wide range of crops, crop rotation does not control it effectively. To protect potato crops from this fungus it is recommended that harvesting and packing in wet weather be avoided and that the tubers be dried thoroughly before being packed.

FIGURE 11.—The dark mass clinging to the outside of this tuber (left) is mycelium and sclerotia of the fungus that causes southern blight, with a mixture of soil. Inside a section of the tuber (right), the fungus appears as a white mass in contrast with discolored decaying inner tissue.

Sclerotinia Rot

In some parts of the South sclerotinia rot of potatoes, caused by the fungus *Sclerotinia sclerotiorum*, is of major importance. In Dade County, Fla., the disease has been gradually increasing in severity and in some years has caused more injury than early and late blights. In parts of Mississippi it has caused complete failure of the potato crop, making it useless to plant potatoes on infested soil.

The fungus is dormant during the summer and during warm, dry weather at other seasons. Sclerotia survive in old plant debris or in the soil (fig. 12.) Development of the fungus is favored by cool, rainy weather, fogs, heavy dews, and shade. The disease becomes most severe near the end of the growing period, when the foliage of potato plants provides dense shade.

The fungus attacks the tops of potato plants but not the tubers. The disease first appears on a stem as a water-soaked lesion, then white mycelium of the fungus grows over the stem surface. All parts of the stem except the outer woody tissues are destroyed, and the interior becomes packed with mycelium and black sclerotia. The plant wilts and finally dies.

Control

Copper and sulfur sprays and dusts applied to potato plants and to the soil immediately surrounding them have not given satisfactory control of sclerotinia rot in Florida. Shallow cultivation once a week to destroy the mushroom-like growth that comes from the sclerotia has helped to reduce the disease. Flooding the land with water and leaving it inundated for about 5 weeks controlled the disease by killing sclerotia.

Cyanimid is toxic to the sclerotia but also to the plants. Applying it to the soil from 45 to 60 days in advance of planting a potato crop allows time for the toxicity to disappear and for the nitrogen to be converted into nitrate nitrogen, which can be used by plants. From

800 to 1,000 pounds per acre should be applied uniformly with a lime distributor and immediately disked into the soil 3 to 5 inches deep.

Fusarium Wilt

Fusarium wilt, caused by the fungus *Fusarium oxysporum*, is a disease of minor importance distributed generally throughout the potato-growing sections of the South.

Plants attacked by *Fusarium oxysporum* may wilt rather suddenly and die in a comparatively short time, or they may show the effects of infection slowly and succumb very gradually. Plants produced from infected tubers may be stunted from the beginning and may die prematurely, without reaching average size, the stalks remaining upright except that the tips may droop. When vines from healthy tubers become infected from neighboring plants or from the soil the first symptom is yellowing and drooping of the lower, older leaves. On hot days yellowing is preceded by wilting of the leaves and stalk.

The stems of affected plants invariably are discolored inside. Their woody tissues are yellow to brown, often from the base well into the top. Tubers from affected plants may show a brown or black discoloration of the vascular ring. Such discoloration cannot be considered a sure symptom of wilt; it may be caused by other conditions.

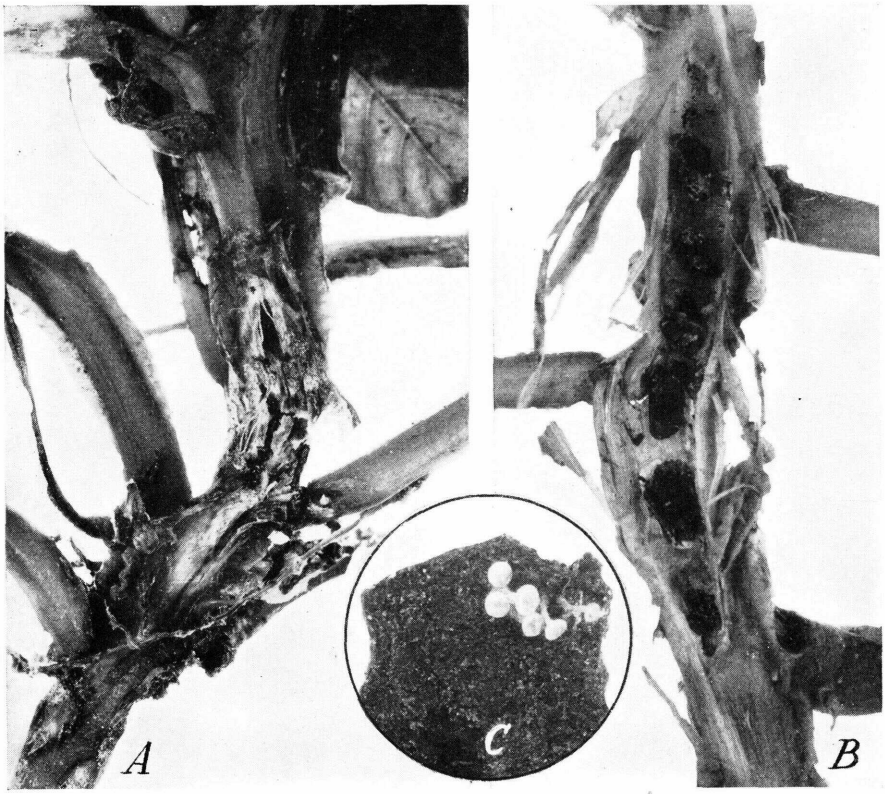

FIGURE 12.—Sclerotinia rot of potatoes: *A*, Lesion on lower part of stem; *B*, sclerotia within opened stem; *C*, 6 apothecia produced by a sclerotium embedded in soil. (Courtesy of Florida Agricultural Experiment Station.)

Control

Because fusarium wilt infection enters tubers mainly through wounds, careful handling of potatoes during harvesting, grading, and packing is an effective means of controlling the disease.

Dry Rots

Dry rots caused by fungi of various *Fusarium* species are likely to occur wherever potatoes are stored.

If sufficient moisture is present, spores of *Fusarium* species including among others *F. caeruleum*, *F. trichothecioides*, and *F. sambucinum* germinate, and the fungi grow, at temperatures within the range 34° to 102° F. White fungus growth of *Fusarium* species often can be seen on the surfaces of tubers. The organism can enter the tubers through lenticels or eyes, but more often it enters through bruises or wounds or through lesions caused by other diseases. A more severe type of rotting seems to be associated with bruising than with any other type of injury studied. Dropping a large tuber a distance of 18 inches can cause an injury sufficient to permit infection.

Fusarium oxysporum sometimes attacks seed pieces in the South after they are planted and causes them to rot, and northern-grown seed potatoes infected with *F. solani eumartii* usually rot after planting, but neither one of these organisms produces a tuber rot in the South.

The lesions produced by most species of *Fusarium* on the surfaces of tubers are sunken and partly covered with clumps of white mycelium and spores of the fungus. Affected parts of the flesh are brown to black. Pinkish, bluish, or whitish tufts of fungus growth are often produced abundantly on the surface of the sunken rotted areas.

Late Blight

Late blight, caused by the fungus *Phytophthora infestans*, is one of the most destructive diseases of potatoes. In most parts of the South, it occurs only infrequently but tends to be more destructive than in other regions because many growers are unprepared to combat it. A severe epidemic may destroy an entire crop within a few days. In Florida and Alabama, because of favorable climatic conditions, the disease generally occurs annually and growers conduct a regular spray program for its control.

Late blight generally affects plants at the blossoming stage or later. In some places the disease may appear much earlier and kill the plants while they are still small.

The first symptoms of late blight are pale-green irregular spots on the leaves. In moist weather these spots increase in size and join each other, the centers turn brown or black (fig. 13), and white mildew develops on the lower side of the

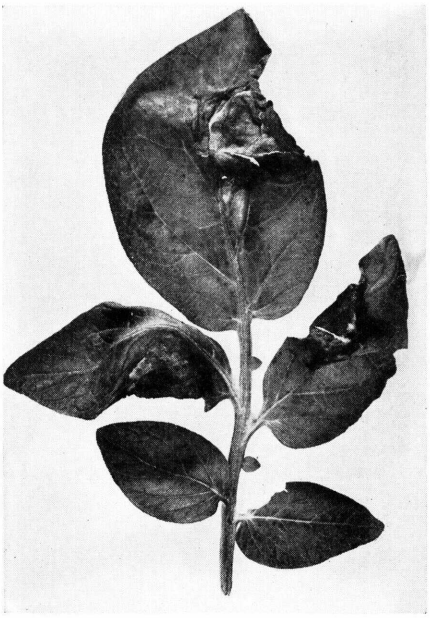

FIGURE 13.—Potato leaf infected with late blight.

leaf under each lesion. If the infection is light, and drying weather prevails, it is difficult to recognize the symptoms accurately. The stems and petioles may become affected, and under humid conditions the entire vine may be killed and blackened within a few days. The decaying tissues have a characteristic moldy odor, which becomes very pronounced in fields that are severely affected.

Spores of the late blight fungus are formed on infected leaves and stems and are carried by splashing rain, wind, and air currents to nearby plants. When deposited on leaves that have droplets of rain or dew on them, the spores germinate and infect the leaves through the breathing pores. The fungus grows into the tissues of the plant, feeds upon cells and kills them, and produces more spores, which infect additional plants.

Under the most favorable moisture conditions and at cool temperatures, spores of the late blight fungus may germinate within 45 minutes; under ordinary conditions, they germinate within a few hours. The spores die within 6 to 24 hours if exposed to dry air.

Tubers still in the soil may be infected by late blight spores washed by rain from blighted tops, and tubers that have been dug may be infected by spores on blighted foliage with which they come into contact. When late blight rot develops on tubers in the soil it spreads irregularly from the surface through the flesh as if it were a brown stain (fig. 14). At first the affected tissue is dry and firm, but the blight rot is often followed by soft rots that destroy the tuber. Some blighted tubers rot in the field, especially in low wet spots.

In storage, the disease is typically a dry rot forming irregular sunken patches. Under conditions favorable for its development—high humidity and high temperature—it may involve the entire tuber. At low storage temperatures, the patches usually remain firm; frequently they have a metallic tinge, especially at the borders.

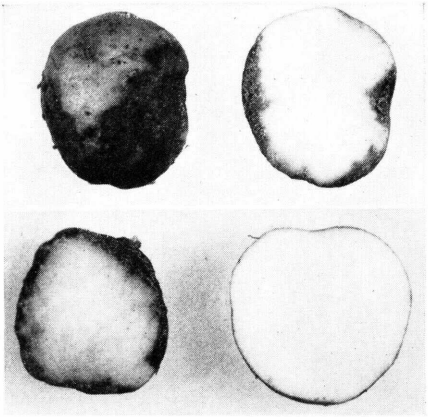

FIGURE 14.—Outside and sectional views of potato tubers affected with late blight, in contrast with a sectional view (lower right) of a healthy tuber.

Control

Spraying or dusting for prevention of late blight should begin when the plants are about 4 inches high and before the disease appears. The fungicide should thoroughly cover the foliage.

If potatoes with partly blighted vines are dug during moist weather, considerable tuber rot may develop. If the freshly dug tubers are picked up moist and taken immediately to storage without drying, ideal conditions are created for development of tuber rot in a high percentage of them.

To avoid late blight tuber rot, it is best to delay digging the potatoes until 2 weeks after the tops die. In order to kill as many of the spores as possible it may sometimes be advisable—particularly if infection has occurred late in the season—to spray the old vines and the entire soil surface at digging time with a solution of copper sulfate (10 pounds in 50 gallons of water).

The most effective way to avoid damage to potatoes from late blight

is to plant blight-resistant varieties. As a result of the national potato-breeding program conducted cooperatively by the United States Department of Agriculture and State agricultural experiment stations, a number of potato varieties have been developed that are resistant to the common strain of late blight (fig. 15). Varieties that are resistant to this strain and also have desirable commercial characters include Kennebec, Pungo, Cherokee, and Essex. At least five other distinct strains of the late blight fungus occur in this country, and these varieties are no less susceptible to them than the ordinary commercial varieties. However, in most potato-producing areas of the South only the common strain of the fungus seems to be prevalent.

Early Blight

Early blight, caused by the fungus *Alternaria solani*, is widely distributed in the South. This disease may cause considerable damage in fields that are not properly sprayed, although it is not nearly so serious as late blight. At one time it ranked as a major disease in southern Florida, but the thorough spray program now conducted there to control late blight has eliminated the early blight problem.

Early blight infection of potato stems and leaves results in development of brown spots, which as they enlarge may form target-board patterns of concentric rings. When the spots become numerous and join each other, the leaves die. This causes a reduction in the yield of tubers. Although named according to its early-season occurrence in other regions, in the South this disease generally does not become evident until the plants reach maturity.

Small, shallow, roughly circular decay lesions are sometimes formed on tubers infected by the early

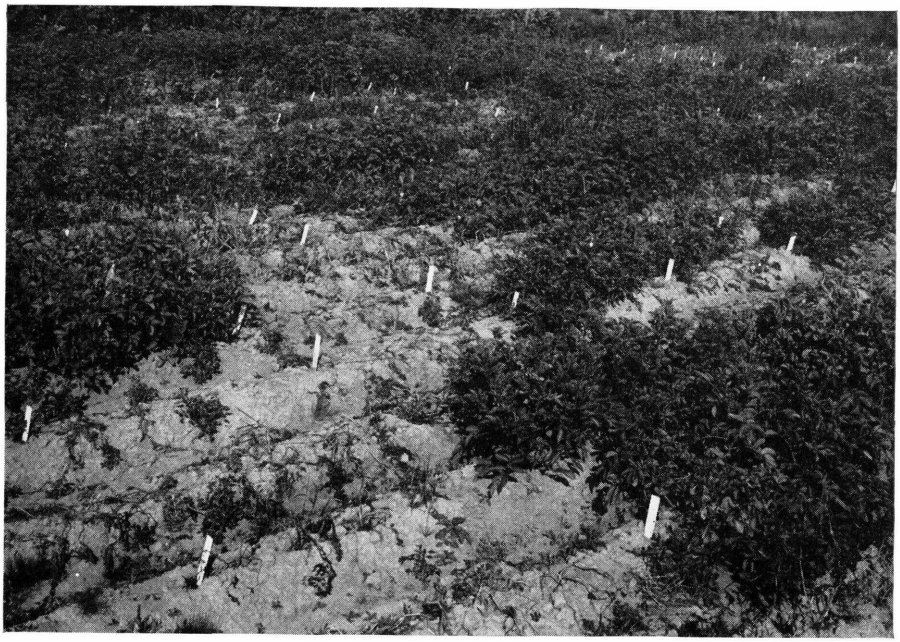

FIGURE 15.—In this potato field, plants of a variety resistant to late blight continue to grow vigorously although plants of a susceptible variety have been killed by late blight.

blight fungus. The margin of a diseased area is raised slightly, and the skin surrounding it is slightly puckered. The lesions give entrance to certain kinds of mold fungi that may complete the rotting of the tuber.

Early blight occurs also on eggplants, tomatoes, and some weeds, and these may serve as sources of infection for potatoes. Spores of the early blight fungus are scattered by wind and rain. A spore falling on a leaf germinates in rainwater or dew and enters the tissue through a breathing pore or directly through the leaf surface. A small spot appears in about 3 days; this enlarges, and a new crop of spores is produced a few days later.

Control

Bordeaux mixture was formerly recommended for control of early blight, but it has not always proved effective. The best control has been obtained by using nabam (Dithane)-zinc sulfate spray.

Spraying and Dusting

Applying a fungicide protects potato foliage from infection that would cause disease; it does not cure a foliage disease. Spraying or dusting should be done as soon as a foliage disease appears or, if there is good reason to believe that such a disease will be prevalent, even before the disease appears. Spraying may have to be repeated at intervals as short as 7 days, according to weather conditions.

Certain types of insecticide can be added to fungicidal sprays or dusts in order that insects and fungi may be killed with the same application.

For control of blight on potatoes, southern growers commonly spray with a 10–5–100 bordeaux mixture. In contrast with the 10–10–100 bordeaux mixture commonly used in the past, this one is nearly neutral. Because it contains less lime, it less frequently has a toxic effect on potato plants. It has given good results as a fungicide, and potatoes sprayed with it have yielded at least as well as those sprayed with the old formula. The 10–5–100 spray mixture contains copper sulfate, 10 pounds; lump lime, 5 pounds (or hydrated lime, 7 pounds); and water, 100 gallons. To make it, put the 10 pounds of copper sulfate in a cloth sack and dissolve it in 50 gallons of water by suspending it overnight just under the surface of the water—or, if you prefer, dissolve the copper sulfate in a little hot water and then add the solution to 50 gallons of water. Carefully slake the 5 pounds of lump lime in a little water and then dilute to 50 gallons—or, if you prefer, mix 7 pounds of hydrated lime in 50 gallons of water. Next, slowly pour the two solutions together into a third container, constantly stirring the mixture. If you do not apply the spray at once, add one-half ounce (2 tablespoonfuls) of sugar, dissolved in a little water, to each 100 gallons of spray mixture. The sugar will keep the spray in good condition for a considerable time; without it, the spray would become worthless in 24 hours.

Some growers have objected to using bordeaux mixture on potatoes on the grounds that the mixture is sometimes toxic, that it is troublesome to mix, and that it corrodes spraying equipment. These drawbacks can be avoided by substituting nabam (disodium ethylene bisdithiocarbamate, commonly known by the trade name "Dithane") or one of the other new organic fungicides.

Nabam, when combined in a spray mixture with zinc sulfate and lime, has given satisfactory control of both early and late blight. As originally made available for use in commercial fields, nabam was a

liquid containing about 30 percent of the active ingredient. A spray solution was made from it by adding 2 quarts of liquid nabam, 1 pound of zinc sulfate, and one-half pound of hydrated lime, in the order named, to 100 gallons of water. Nabam-zinc sulfate (tank mix), a factory-made product now available that does not require addition of lime, has given equally satisfactory results.

In Dade County, Fla., for example, before the 1943–44 season, copper fungicides such as bordeaux mixture, wettable cuprous oxides, copper oxychloride sulfates, basic copper sulfates, and copper-lime dusts gave good control of late blight. During that season, however, when late blight became widespread and severe several weeks earlier than usual, copper sprays and dusts failed to control the disease even if applied twice a week. On the other hand nabam-zinc sulfate spray, used at Homestead in 1943–44 for the first time, gave outstanding control of blight. Since then, almost all potatoes in the Homestead area have been treated with this spray, and with very few exceptions the results have been excellent. Where this spray is used it should be applied at least once a week during periods when conditions are favorable for blight infection, because it loses much of its effectiveness when it has been on the vines 8 to 10 days.

Several other organic fungicides that have been used experimentally have given results on potatoes comparable to those obtained with nabam-zinc sulfate spray.

Because of climatic differences, it is not advisable to make general recommendations for the use of any particular fungicide throughout a region. Before using any of the newer fungicides on a large scale, the southern potato grower should ask for advice from the plant disease specialists of his State agricultural college.

Success in controlling early and late blights on potatoes depends not only on when and how often a fungicide is applied but on how it is applied. The vines must be covered thoroughly. Best results are obtained with a tractor-drawn, power-operated sprayer or duster equipped with 10- or 12-row booms so designed that 3 to 6 nozzles can be used on each row and several of these can be dropped so as to operate between rows. When the plants are small, at least 3 nozzles per row should be used; as they grow larger, 4, then 5, and possibly 6 nozzles per row can be used effectively. The quantity of spray solution needed per acre application ordinarily ranges from 125 to 175 gallons; it varies with the quantity of vine growth. When vine growth is heavy, vine lifters should be used on the tractor and sprayer wheels so that the wheels will do less injury to the vines.

Although dusts are ordinarily used less than sprays for potatoes, some growers prefer to apply a copper-lime dust rather than a spray for control of foliage diseases. In comparison with spraying, dusting is easier and can be done with lighter, less expensive, and less complicated machinery. To take effect fully, dust should be applied when the leaves are moist; otherwise it is likely to be blown off. Early morning, when the leaves are covered with dew, is a good time to dust.

A mixture of 1 part monohydrated copper sulfate and 4 parts hydrated lime with 3 or 5 percent DDT added for control of certain insects makes a very satisfactory dust for potatoes. The percentage of copper sulfate can be varied. For good vine coverage, the materials must be so fine that 95 percent of the mixture will pass through a 200-mesh sieve. Nabam dust, also,

effectively controls early and late blights.

Special circumstances sometimes make it preferable or necessary to use a dust. For example, frequently it is impossible to operate large, heavy sprayers on muck land and hard to operate them on hilly land, and in many places it is hard to get water for the spray tank. When potato fields become so boggy from continued wet weather that neither spraying nor dusting machinery can be operated on them, dust can be applied by airplane. Dusting by airplane is quick and does not cause vine injuries; however, it seldom results in good vine coverage.

ROOT KNOT

Numerous species of nematodes, or eelworms, attack the roots and tubers of potato plants in the South. The most widely distributed of these are root knot nematodes (species of *Meloidogyne*, formerly known as *Heterodera marioni*). These nematodes attack potato roots and cause knots, irregular swellings, and malformations, which are frequently called root galls. When root growth has stopped, they attack the tubers and cause them to be disfigured by knotty outgrowths and blackening, shriveling, and cracking of outer surfaces (fig. 16, *A* and *C*). When tubers thus affected are cut, glistening whitish spheres (fig. 16, *B*), only large enough to be visible to the naked eye, are often found just beneath the surface. Each of these spheres is a female root knot nematode. Eventually, the tissue turns black and decays.

By attacking the roots, root knot nematodes deprive the potato plant of much of its vigor. They particularly interfere with the intake of

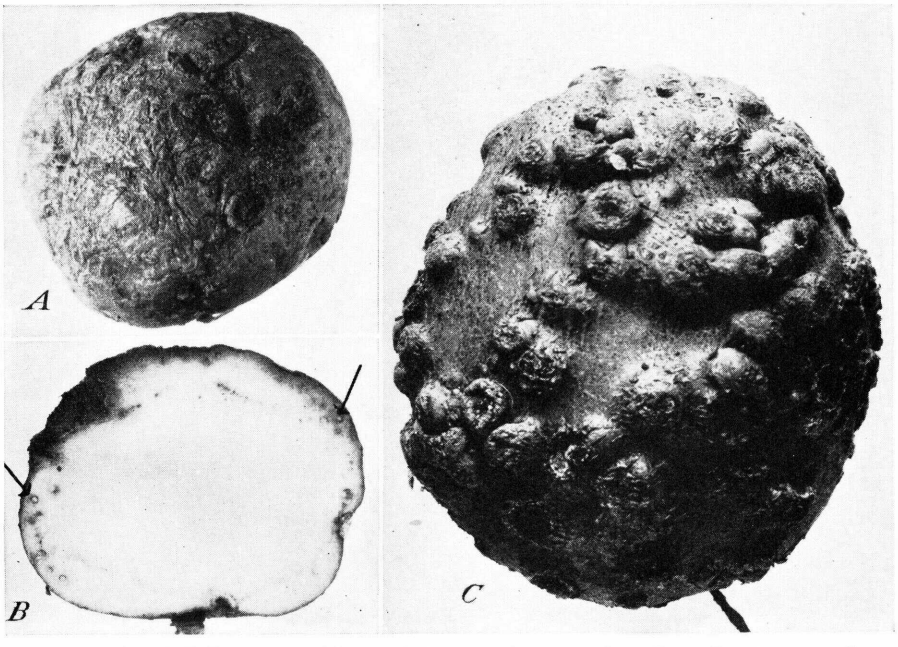

FIGURE 16.—*A*, Injury caused to a potato tuber by a species of root knot nematode. *B*, Cross section of tuber shown in *A*. The small spheres indicated by arrows are female nematodes embedded in the tissue. *C*, Root knot injury of an extreme type found in Florida and some other Southern States, caused by a different species of root knot nematode.

moisture, so that heavily attacked plants often wilt during the hot period of the day. By disfiguring the tubers they sometimes make them unsalable.

Since root knot nematodes are less active during cool weather, planting of potatoes in infested soil should be done early so that the plants may form good root systems before the main invasion occurs.

A 3-year crop rotation generally suffices to control root knot nematodes. Grains are generally the most satisfactory rotation crops. In the South heavy infestation of potato fields with root knot nematodes may be greatly reduced by growing cover crops immune to root knot for at least one season; *Crotalaria spectabilis* or *Crotalaria juncea* in summer and oats in winter are recommended. Flooding the land for several months reduces the infestation. Under dry conditions, infestation has been reduced by fallowing with repeated plowing and cultivation during the hot season.

Soil fumigants containing either dichloropropene - dichloropropane or ethylene dibromide as the active ingredient, at concentrations recommended by the manufacturers, are effective in eliminating root knot nematodes, but generally control by use of these preparations is too expensive.

Potatoes should never be used for seed unless they are absolutely free from root knot nematodes.

VIRUS AND VIRUSLIKE DISEASES

Virus and viruslike diseases include rugose mosaic, mild mosaic, leaf roll, spindle tuber, and others of less importance. These diseases, with the single exception of purple top wilt, result from infections carried in the seed tubers and cannot be cured by sprays or dusts. Their control, therefore, depends entirely on the seed-potato growers, who must eliminate virus-infected plants by roguing. Certified seed generally contains only very small percentages of virus-infected tubers.

If a grower of table potatoes finds a small number of virus-infected plants in his fields, he should not remove them. Although some other plants in the fields may become infected on account of spread by insects, reduction in yield from such infection will be negligible. Plants growing from virus-infected tubers produce lower yields, but ordinarily the quality of the tubers they produce is not noticeably affected. Growers of table potatoes in the South are not advised to practice any virus-control measures. This recommendation, of course, does not apply to potato growing in the elevated areas of the South suitable for seed production, where growers produce their own seed. The proper procedure for growers in those areas to follow is described in Department of Agriculture Circular 764, Production of Disease-Free Seed Potatoes.

To enable growers of table stock to recognize the more common virus diseases of potatoes, symptoms of the various diseases are briefly described.

Mild Mosaic

Mild mosaic can be recognized by a leaf mottling in which yellowish or other light colors alternate with the normal green. The mottled areas (fig. 17) vary in size and are not restricted by the veins of the leaf as in rugose mosaic. The leaf mottling is accompanied by a slight crinkling. Diseased plants droop and die prematurely, especially during hot, dry weather.

Rugose Mosaic

Rugose mosaic is a disease entirely different from mild mosaic, and a more serious one. Its leaf-

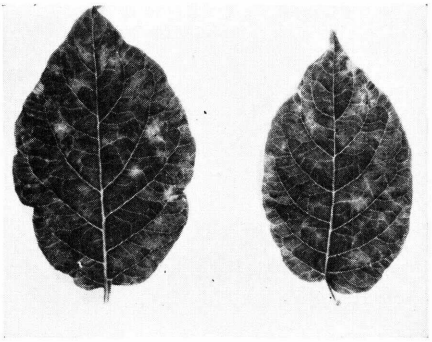

FIGURE 17.—Leaflets from a Green Mountain potato plant infected with mild mosaic. Note that the yellow patches do not follow the veins.

pattern symptom is a distinct mosaic differing from that of mild mosaic in that the discolored areas are smaller, more numerous, and closer to the main veins. Although high temperature masks the mottling, the disease can always be identified by the crinkly, rugose appearance of the leaves. The veins of the lower leaves often show dead areas resembling black pencil lines, and these leaves tend to become somewhat brittle. As a rule, affected plants become considerably stunted and die much earlier than healthy ones.

In this disease, plant symptoms due to current infections are different from those that develop in plants grown from tubers infected the previous season. If small, angular dead patches occur on the leaves in midseason, and if burning and discoloration of the leaf veins, brittleness, and leaf drop also occur, the trouble is probably due to current-season infection with the rugose mosaic virus (fig. 18).

Leaf Roll

Leaf roll is recognized by the characteristic lengthwise upward rolling of the leaflets, which causes each leaflet to form a trough (fig. 19). First the lowest leaves of the

FIGURE 18.—Dying and dropping of lower leaves of this plant indicated that it had become infected with the rugose mosaic virus from some source other than the seed tuber.

young plants roll, then progressively higher ones do so until finally all the leaves may be rolled. Other symptoms may include dwarfing, rigidity, leathery texture, yellowing, reddish or purplish discoloration of the affected leaves, and reduction in the number and size of tubers.

FIGURE 19.—Katahdin potato plant affected with leaf roll.

Spindle Tuber

The most prominent symptoms of the disease called spindle tuber are erect, somewhat spindly growth and stunted size. Generally the green of the foliage is noticeably darker than normal. The leaves, instead of curving out normally, usually are set at an acute angle with the stem. The erectness and the reduced growth are sometimes so pronounced that they give the diseased plants a distinctly abnormal appearance.

In most varieties the tubers become elongated and spindle shaped—that is, pointed at one or both ends (fig. 20). In some of the round varieties, such as Triumph and Irish Cobbler, the tubers are elongated but are not pointed at the end and thus tend to be cylindrical. Affected tubers of the Triumph variety are also a lighter red color than the healthy ones.

DISEASES DUE TO NONPARASITIC CAUSES

Some diseases of potatoes are not caused by an organism or virus but arise from unfavorable growing conditions.

Internal Brown Spot

Internal brown spot, a disease common in some seasons, consists in irregular-shaped brown spots scattered through the flesh of potato tubers (fig. 21). These spots are masses of dead cells. They are free from bacteria and fungi. Internal brown spot is believed to be due to excessive evaporation from the foliage and to lack of water at some critical stage of the growth of the plant, resulting perhaps from poor soil texture or from alternating wet and dry weather.

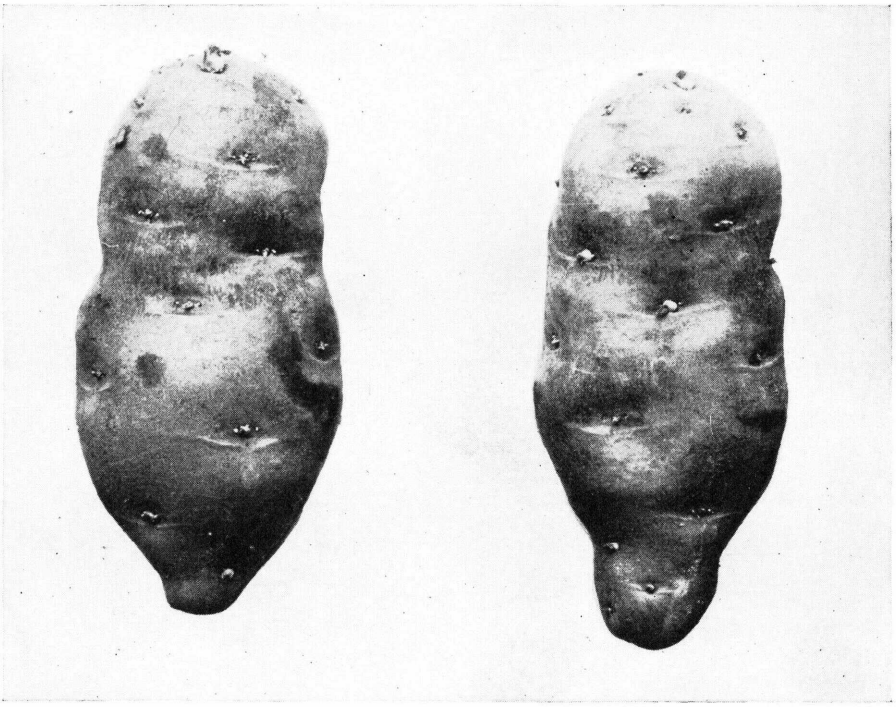

FIGURE 20.—The elongated, pointed form of these tubers is characteristic of those affected with the disease called spindle tuber.

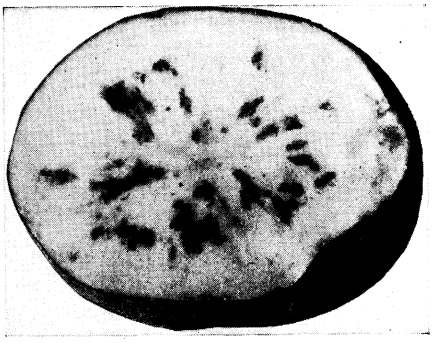

FIGURE 21.—A potato tuber affected with internal brown spot.

Blackheart

Blackheart occurs as jetblack, moist, flabby tissue in or near the center of the tuber. In advanced stages, the tuber has a black-bordered cavity at its center. Whenever the discoloration progresses far enough to reach the surface of the tuber, rapid decay sets in.

Blackheart develops when potatoes are heated to 100° F. or higher for a few hours. The disease may result also when potatoes are stored at lower temperatures but piled deeper than 6 feet without adequate ventilation at the sides or bottom of the pile.

Hollow Heart

"Hollow heart" is the name applied to a conspicuous cavity at the center of a potato tuber. Usually the tissue surrounding the cavity is free of discoloration, but sometimes it has a brownish, corky appearance. This condition is commonly confined to large tubers and occurs mainly in seasons when conditions are favorable for rapid growth. Some varieties are more likely to develop hollow heart than others. Pontiac may readily develop it, if plants are spaced too far apart in fertile soil.

This trouble can largely be avoided by spacing the plants closely, which will help to prevent rapid and uneven growth.

Enlarged Lenticels

If potato tubers are left in very wet soil for some time after they mature, or if freshly dug tubers are stored in a place where the air is very moist, frequently this results in abnormal development of the lenticels, which under normal conditions are small, inconspicuous slits scattered over the surface of the tuber. The lenticels become scablike openings filled with light-colored growths that look as if they had been pushed out from below. Frequently these growths become corky in appearance.

Spindling Sprout (Hair Sprout)

Spindling sprout, or hair sprout, is a weakness of the potato tuber that causes sprouts to be abnormally slender and feeble (fig. 22). Some of the sprouts have diameters only about one-half to one-quarter as great as those of normal sprouts. If tubers affected with spindling sprout are used as seed, the plants grown from them produce only undersized tubers. However, if these tubers are used as seed, the plants grown from them produce normal tubers. In other words, spindling sprout is not transmitted to the third generation.

Tubers infected with the virus causing leaf roll or the one causing witches'-broom often produce sprouts similar in size and appearance to those produced by tubers affected with spindling sprout. Such infected tubers should not be confused with those having spindling sprout.

Corky Ring Spot

Corky ring spot, a potato disease that has been known for some time in European countries, Indonesia, and South Africa, has recently been reported from Florida. It is not known to have been observed in any other Southern State. In Florida it appeared on three farms at

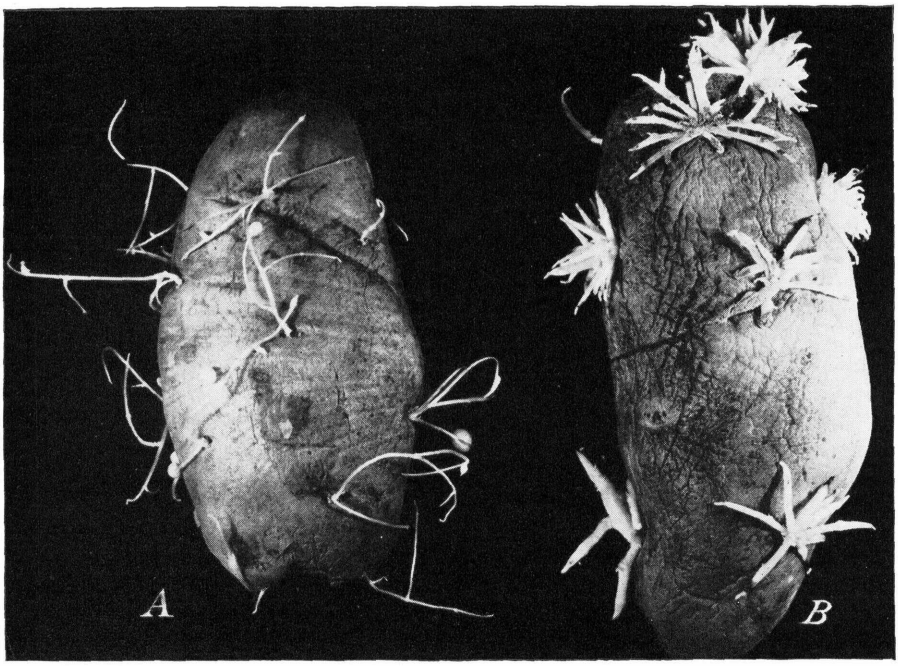

FIGURE 22.—*A*, White Rose tuber, kept in storage for 12 months, producing the slender, feeble sprouts characteristic of the disease spindling sprout; *B*, healthy tuber of the same crop likewise stored.

Hastings and caused tuber losses that varied in different fields from a trace to 50 percent.

The cause of corky ring spot is unknown. The disease does not seem to be hereditary. Tubers affected with corky ring spot in the early stages of growth become irregular in shape owing to the development of deep cracks and shallow corky depressions on their surfaces. Brown concentric rings and arc-shaped lesions are evident on the surfaces of many of the tubers (fig. 23). Brown discolorations of the flesh may appear in the form of rusty-brown blotches of different irregular shapes and different sizes or in the form of arcs or rings centering in the original points of infection on the surface of the tuber. The discolored flesh has a corky texture. No fungus or bacterial growth is evident in the dead tissues. No control method is known.

INSECTS AND THEIR CONTROL

Potatoes grown in the South are subject to injury by many kinds of insects. Usually the most widely destructive of these are aphids, the Colorado potato beetle, flea beetles, the potato leafhopper, and wireworms. In some areas of the South and in some seasons, potato losses are caused also by blister beetles, cutworms, leaf miners, mole crickets, plant bugs, the potato tuberworm, the seed-corn maggot, thrips, the vegetable weevil, white-fringed beetles, and white grubs. Still other insects attack potatoes in the region occasionally. Some insects bite out parts of the leaf, stem, or tuber; others suck sap or juices from some part of the plant. Certain insects cause more damage by carrying viruses and bacteria than by their feeding.

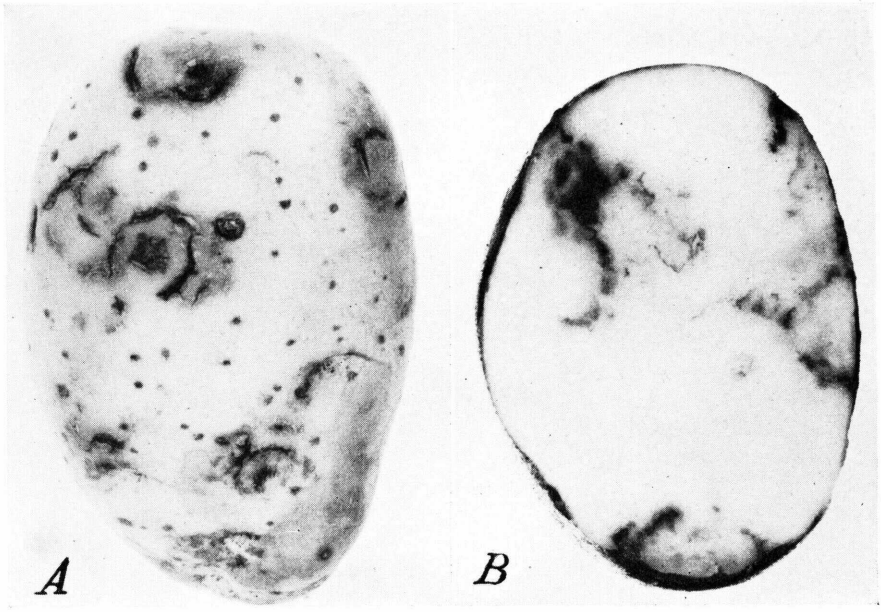

FIGURE 23.—Potato tubers affected with corky ring spot, showing ringlike lesions on the surface (left) and discolorations of the flesh (right). (Courtesy of Florida Agricultural Experiment Station.)

Control of insect pests is an important factor in production of potatoes in the South. Cultural practices, natural enemies, and weather conditions often play important roles in the control of these pests, but they can seldom be depended upon to give adequate protection; as a rule, insecticides are needed. In order to get best results in efforts to control insects injurious to potatoes you must first identify the insects. Descriptions that will help you to do this are given in the next two sections. Under the heading "Use of Insecticides" (p. 49), recommended dosages of common insecticide formulations are given. After these (p. 51) comes a list of precautions that you must take in order to use insecticides safely. Finally, the scientific names of insects discussed are listed (p. 52).

Unusual outbreaks of insects should be reported to your county agricultural agent, your State agricultural college, or the United States Department of Agriculture, Washington 25, D. C.

INSECTS CAUSING THE MOST WIDESPREAD DAMAGE

Aphids

Several species of soft-bodied plant lice, or aphids, feed on potatoes in the South. The most common of these are the green peach aphid and the potato aphid, sometimes called the green or the pink potato aphid. Under conditions favorable to the insects almost every plant in a potato field may become infested with hundreds of aphids. Both adult aphids and their young, which are called nymphs, suck the sap from potato foliage and thus cause the leaves to curl downward, turn yellow, and die. Severe direct injury to potatoes by aphids, however, is not common in the South. The most serious effect of infestation of southern potato fields by aphids is the spread of viruses car-

ried by these pests, particularly the viruses causing leaf roll and mosaic diseases.

The nymphs look like the adults except that they are smaller and wingless. Aphids reproduce rapidly in warm weather and cause most damage during warm, dry seasons. They do not thrive, however, in extremely hot, dry weather. In the South aphids usually do not lay eggs but give birth to living young. Several generations occur each year.

Control

Aphids on potatoes can be killed by dusting or spraying with DDT, parathion, malathion, nicotine, or rotenone. DDT does not always give good control of the potato aphid. It should be applied at the highest dosage recommended. Parathion is usually very effective, but it must not be applied without special precautions (p. 51). Nicotine usually gives satisfactory results if applied when the air temperature is 70° F. or above.

Watch potato plants carefully for aphids, begin applying an insecticide when aphid population is low, and repeat once a week as long as necessary.

Colorado Potato Beetle

The Colorado potato beetle is one of the most widespread and destructive insect pests of potatoes in the South (fig. 24). (It feeds also on tomato and eggplant.) Both larvae and adults feed on potato leaves. When abundant and uncontrolled, they leave only the bare stems. The

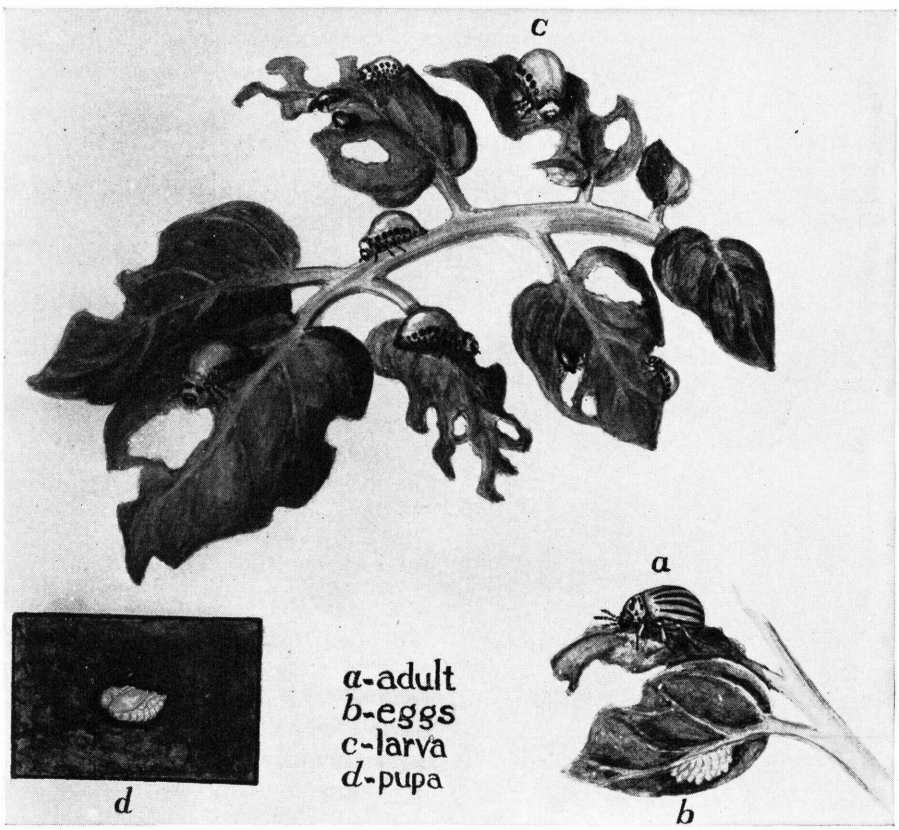

FIGURE 24.—Life stages of the Colorado potato beetle.

insect also spreads several potato diseases from plant to plant.

This insect first appears in the spring in the form of the adult, or hard-shelled beetle, which is about ⅖ inch long, stout, roundish, and of a light yellowish color, with 10 black stripes down its back. The female beetles lay orange-red eggs in batches of 5 to 70 on the under sides of potato leaves. These eggs hatch in from 4 to 9 days into small larvae, or slugs. The slugs have soft bodies that range in color from lemon to reddish brown and are marked with two rows of black spots on each side. The head and legs are black. For about 2 weeks the slugs feed greedily, devouring large quantities of potato foliage, and grow rapidly. At the end of this time they have reached full growth and are about ⅗ inch long. They then drop from the plants and enter the soil, where they change to the inactive, or pupal, stage. After remaining in this stage for a brief period the length of which varies according to time of year and locality, the insects become adults and emerge from the soil. The life cycle requires about a month, and two or three generations develop each year in the South. Earliest potato plantings are likely to be the most seriously injured.

Control

The Colorado potato beetle can be controlled by dusting or spraying with DDT, heptachlor, dieldrin, rotenone, or cryolite. Begin using one of these materials as soon as the first eggs hatch, and apply it again every 10 to 14 days as long as necessary. Two or three applications usually suffice. Calcium arsenate, also, will control the Colorado potato beetle, but using it often causes an increase of aphids.

Flea Beetles

Several kinds of flea beetles attack potatoes in the South. The most widespread and destructive of these is the potato flea beetle. Adult flea beetles chew many small holes in potato leaves, giving them a sievelike appearance. Badly eaten leaves wither and die, with the result that tuber growth is reduced. The larvae attack underground parts of the plants. Certain kinds scar potato tubers and may bore into them, discoloring the tissue and thereby causing waste when the potatoes are pared for use.

Flea beetles hibernate, usually as adults, in the soil, in crop residues, and in grass or weeds growing along the edges of fields and woods. The eggs, so small that they are rarely seen, are deposited in cracks in the soil. They hatch within a week. The threadlike larvae are about one-third inch long when full grown. They pupate in the soil. The life cycle is usually completed in about 6 weeks. In the South flea beetles may produce as many as four generations each year.

Control

Flea beetle injury to the foliage can be prevented by dusting or spraying with DDT, heptachlor, dieldrin, rotenone, or cryolite. DDT usually is the most effective of these, but in recent years it has not always given satisfactory results in certain areas. Calcium arsenate can be used but may cause an increase of aphids.

Populations of flea beetle larvae in the soil are reduced by soil applications of aldrin, chlordane, dieldrin, and heptachlor made primarily for control of wireworms and of white-fringed beetles, as described on pages 42 and 47.

Potato Leafhopper

The potato leafhopper is an important pest of potatoes in many parts of the South. This insect weakens the potato plant by sucking the sap from leaves and stems. As the leafhopper feeds it deposits a

poisonous substance, which causes a condition known as hopperburn. The tips and margins of leaves on affected plants curl upward, turn yellow, and finally become brown and brittle. Plants heavily infested with leafhoppers may die prematurely.

The potato leafhopper is a green wedge-shaped insect about one-eighth inch long. It feeds chiefly on the under sides of the leaves. The adults are very active. While walking through an infested field you may see them darting from plant to plant. Lower leaves of the potato plant harbor the immature leafhoppers, which resemble the adults in shape but are paler and wingless. If disturbed the young leafhoppers scamper for cover, traveling sidewise.

Control

To control leafhoppers, apply a DDT dust or spray to the foliage. Make sure that the insecticide reaches the under sides of the leaves. Parathion, used primarily for the control of aphids, kills leafhoppers also.

Wireworms

The southern potato wireworm and the Gulf wireworm are major insect pests of potatoes in the South, especially in the early-season producing areas in the Southeast. The southern potato wireworm, which is not known to have been present in North America before 1927, is now the most abundant wireworm at least in potato-producing areas of northern Florida, southern Alabama, and coastal sections of the Carolinas. Other wireworms, of the genera *Melanotus* and *Glyphonyx*, feed on potatoes in certain areas of the South.

Wireworms are the soil-inhabiting larvae of a group of insects popularly known as click beetles or snapping bugs. Adults of wireworms that damage potatoes in the South are slender, hard-shelled, about one-fourth to three-fourths inch long, and reddish brown to black. When placed on their backs the beetles snap their bodies, with an audible click, and thereby throw themselves upward. The beetles lay tiny white eggs in the soil, usually during spring and summer. The eggs usually hatch in 1 to 2 weeks.

When first hatched, wireworms are white. Gradually they turn dark yellow or orange. They have rather hard, almost cylindrical, jointed bodies that are one-half to three-fourths inch long when full-grown. The larval stage of the Gulf wireworm lasts about a year. Pupation occurs in the soil at depths of about 3 to 4 inches, chiefly during the spring and early summer. The pupal stage usually lasts 1 to 2 weeks.

In most areas of the South, wireworms injure potatoes chiefly by feeding on the tubers. They chew pits or holes that sometimes extend halfway through the tuber (fig. 25). Their injury lowers the market grade of potatoes and makes some of them unmarketable. Washing of potatoes before shipment to market often reveals feeding holes not otherwise noticeable. The wireworms stay in the tubers only while feeding and consequently are rarely found in them. They also feed to some extent on potato stalks and roots and, in some areas, on the seed pieces. Holes made in the tubers, stalks, and seed pieces permit entrance of certain disease organisms and other insects. The damage directly and indirectly done by wireworms is often considered the most important of all tuber injuries.

Control

No satisfactory direct control of wireworms was known until in recent years several newly developed organic insecticides were found to

be effective when applied to the soil. Studies of these materials are still under way, and many details of their use remain to be worked out.

Potatoes being grown in the South can generally be protected by applying to the soil 2 pounds of dieldrin, 2 to 3 pounds of heptachlor or aldrin, or 4 to 6 pounds of chlordane per acre. These treatments may be effective for 2 or 3 years. Do not exceed these dosages. Consult your county agent or State agricultural college about the need for repeat applications in your area.

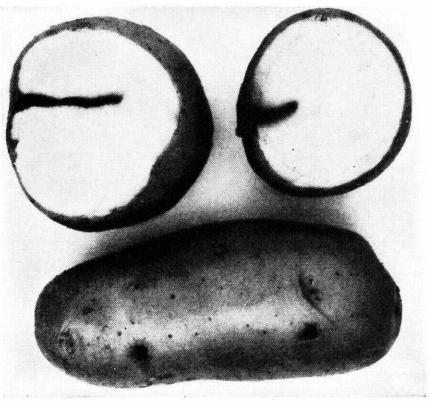

FIGURE 25.—Potato tubers tunneled by wireworms.

The insecticides should be applied before the crop is planted, preferably after the land has been plowed. They should be applied broadcast to the soil surface and disked or otherwise thoroughly mixed at once into the upper 4 to 6 inches of soil. Custom-mixed combinations of fertilizer and insecticide are preferred by many growers in the South and usually have given satisfactory wireworm control when properly prepared, applied broadcast, and well mixed into the soil before planting time. Band and furrow applications have given satisfactory results in some cases.

The insecticides may be distributed in sprays, dusts, or granules, depending on the type of equipment available. Granules can be applied with some types of dusting equipment. They are well adapted for aerial applications, readily penetrate through foliage, and do not blow away so much as dust mixtures.

Certain cultural practices and crop rotations result in lower populations of some species of wireworms. Owing to variation in the habits of different species of wireworms and to differences in soils, climate, and cropping systems in various parts of the South, no general statement can be made as to what practices and rotations have most value in this respect. Local experience must serve as the guide. Matured early potatoes should not be left in soil infested with wireworms and other soil-inhabiting insects that feed on the tubers.

INSECTS CAUSING DAMAGE LESS WIDELY OR LESS OFTEN

Blister Beetles

Blister beetles occasionally cause considerable injury to small plantings of potatoes in the South. These insects, in certain areas, are called old-fashioned potato bugs. The kinds usually most abundant in the South are the striped blister beetle, the margined blister beetle (fig. 26), the black blister beetle, and the ash-gray blister beetle. They range in color from dull red to gray or black; some are striped, others are of a solid color. They vary in size, the striped ones being about two-fifths inch long. In comparison with most beetles, blister beetles are rather long, slender, and soft-bodied.

Blister beetles often appear suddenly and in great numbers in a potato planting, strip the leaves down to the midrib, and disappear. They usually feed in groups and scatter when disturbed.

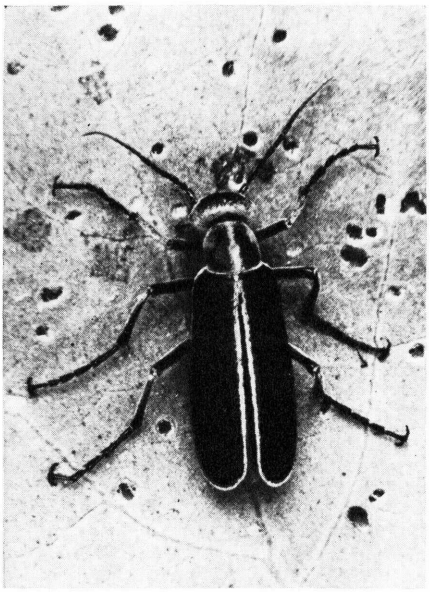

FIGURE 26.—Margined blister beetle feeding on a potato leaf. (Enlarged.)

Control

As blister beetle infestations in potato fields usually cannot be foreseen, control measures must often be taken on short notice. Spraying or dusting with DDT or toxaphene will usually check injury by these insects. Direct the insecticide onto the beetles rather than onto the foliage, for they clean their bodies with their legs and then draw the legs through the mouth parts. In small plantings, apply the insecticide around an infested area first, to keep the beetles from spreading, and gradually work toward the center. Applications of DDT made primarily for control of other insects usually prevent blister beetle outbreaks in large plantings.

Cutworms

Several species of cutworms occasionally cut off the stems and feed on the tubers of potatoes in the South. Cutworm injury to the tubers resembles that done by mole crickets (fig. 27) except that the cutworm holes may be deeper. The species usually most abundant in the larger potato-producing areas are the granulate cutworm, the black cutworm, and the variegated cutworm. The variegated cutworm and the granulate cutworm may climb the plant and feed on the foliage.

Cutworms are the larvae of mottled brown or gray night-flying moths. The larvae are brownish, greenish, or gray, some with faint spots or lines down the back. They are plump, nearly hairless, and nearly 2 inches long when full grown. They have the habit of curling the body tightly when disturbed.

Control

Damage to potatoes by some kinds of cutworms may be reduced by plowing in the fall and by rotating crops so that potatoes do not follow grass or sod. Cutworms can be controlled by spraying or dusting toxaphene onto the soil surface—or onto the foliage if the larvae are climbing the plants. Similar use of DDT will kill certain kinds of cutworms. Granular formations of these materials usually penetrate the foliage better than dusts or sprays.

Leaf Miners

Leaf miners, the tiny maggots of several species of small flies, occasionally make long winding tunnels or mines between the surfaces of potato leaves in southern Florida and other areas in the South. They become a serious problem in some years. The serpentine leaf miner is one of the troublesome species.

Control

Applications of parathion or dieldrin will usually control leaf miners.

Plant Bugs

Several lygus bug species, the leaf-footed bug, and the southern green stink bug occasionally suck the juices from the leaves or stems

of potato plants. Their feeding causes the tender foliage to wilt or die.

Control

Foliage applications of DDT or aldrin will control lygus bugs, and similar use of dieldrin is of value both against lygus bugs and against stink bugs. Parathion, applied primarily for the control of aphids, will also reduce populations of some of the plant bugs. A general clean-up of weeds in the fall around fields to be planted to potatoes helps reduce populations of these insects.

Thrips

The tobacco thrips and the onion thrips feed on potatoes in the South, causing considerable damage at times. These are very small and slender insects, yellowish to brownish in color. They rasp potato leaf surfaces and suck juices from the tender leaves. Potato plants heavily infested with thrips have a silvery appearance and become stunted.

Control

Thrips can be controlled in most cases by foliage applications of DDT, aldrin, dieldrin, or toxaphene.

Mole Crickets

Mole crickets, particularly the southern mole cricket and the changa (or Puerto Rican mole cricket), occasionally feed on the roots, stems, and tubers of potatoes in the South (fig. 27). They eat relatively large, shallow holes in the tubers, the injury being similar to that caused by cutworms and white grubs.

Mole crickets have short, stout front legs and shovel-like feet adapted to digging. When full grown, they are about 1½ inches long and range from light velvety brown to blackish in color.

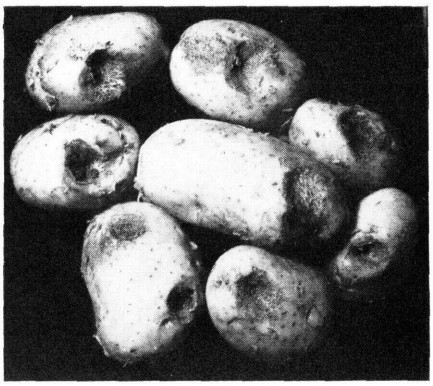

FIGURE 27.—Potato tubers damaged by mole crickets.

Control

Mole cricket injury can be prevented by applying chlordane, dieldrin, aldrin, or heptachlor to the soil surface at a rate of about 2 pounds per acre before the crop is planted. The insecticide may be used in a spray, dust, or bait. Special-order fertilizer preparations into which the proper amount of one of these insecticides has been thoroughly mixed have given good control of mole crickets in the South when broadcast. Chlordane has been used extensively in this manner in certain areas. Application of one of the four materials just mentioned for the control of wireworms or white-fringed beetles usually protects potatoes satisfactorily against mole crickets for at least one season.

Potato Tuberworm

Potato tuberworms feed on the leaves and stems of potato plants and also attack the tubers both in the field and in storage. They usually do their greatest damage to stored potatoes.

The adult of the potato tuberworm is a gray moth active only at night. It is not more than one-fourth inch long and has dark-brown or black markings on the wings. The female lays from 150

to 200 tiny eggs on the undersides of potato leaves or in the eyes of any part of a tuber that is exposed aboveground.

The full-grown larva is about one-half inch long. It has a brown head and a pinkish or white body with a wide reddish-purple band down the back. On potato foliage the larvae join the tips of 2 or 3 leaflets together with a silky web and feed under the protecting cover thus formed. They may tunnel in the midrib of the leaf and in the stem of the plant. In the tuber they may burrow just under the skin or tunnel into the flesh.

The life cycle may be as short as 2 weeks in summer and as long as 7 months in winter. There are 5 or 6 generations a year in the South. In warm storage this insect may continue its life cycle all winter; in the field it overwinters as a larva or pupa in the soil.

Control

Preventive measures usually control the potato tuberworm in the United States. The first step in preventing infestations is to plant seed pieces that are not infested. In cultivating the soil, hill the plants, so that the tubers will not be exposed to egg-laying moths. At digging time, do not leave the tubers in the field overnight and do not cover piles of dug tubers with potato plants. Destroy cull potatoes; leaving them piled up, either in storage or in the open, tends to increase the tuberworm population. After potatoes have been harvested, store them in clean, uninfested places. In warm weather all outside openings of storage places should be screened to keep out moths.

To protect potatoes that are to be used as seed, give them a light coating of a 3-percent DDT dust.

To kill tuberworms feeding on potato foliage, make one or two applications of a DDT dust or spray.

Seed-Corn Maggot

The seed-corn maggot is the most destructive of several maggots that occasionally attack potato seed pieces (fig. 28). Sometimes heavy infestations of this insect in potato fields make it necessary to replant.

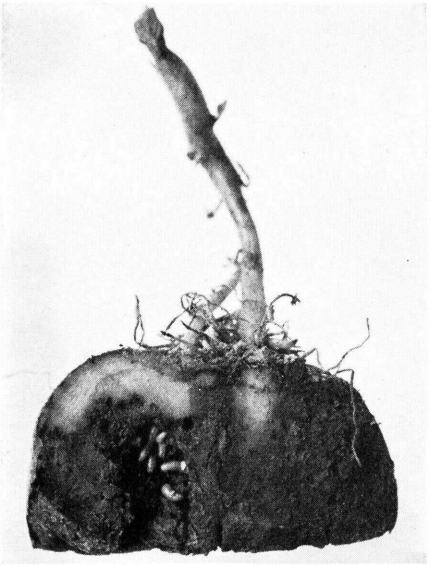

FIGURE 28.—Seed-corn maggots feeding within a potato seed piece, a part of which has been cut away to show them.

These dirty-looking, yellowish-white maggots are about one-fourth inch long when full grown. They do their greatest damage in cool, wet springs and in soils containing large amounts of decaying vegetation or organic fertilizer. They enter potato seed pieces chiefly through cut surfaces that have not healed properly. The maggots sometimes carry the bacteria that cause the blackleg disease of potatoes and may spread the disease by feeding on potato seed pieces.

The adult flies are about one-fifth inch long and grayish to nearly black. They lay their eggs in soil that contains an abundance of decaying organic matter. In coastal areas of the Southeast, the

insect breeds throughout the winter and attacks early spring potato plantings. In interior areas, later plantings are subject to injury.

Control

The best way to prevent the seedcorn maggot from injuring potatoes is to plant only well-healed seed pieces. Cut potatoes at least a week before planting and subject the cut seed to conditions favorable for the healing over of the cut surfaces (see p. 8).

Vegetable Weevil

The vegetable weevil, a snout beetle that has become more widespread in the South in recent years, sometimes attacks potatoes. The beetles feed first on the buds of potatoes, thereby stunting the plants, and later on the leaves. They may cut off the stems of young potato plants at ground level, as do cutworms. The larvae occasionally feed on tubers that are near the surface of the soil.

The adult weevil is about three-eighths inch long and is dull grayish-brown in color, with a pale-gray **V** near the tip of each wing cover. Like many other weevils, the adults "play dead" when disturbed; they fall on their backs, draw in the antennae and legs, and remain motionless for several minutes. This habit and their color make them difficult to see on the ground. Adults live for about a year, but they hide and are inactive during the summer. They deposit eggs on potato plants or other vegetation or on nearby soil, usually between October and April.

The full-grown larva is greenish, about one-half inch long, slender, and strongly convex. The life cycle from egg to newly emerged adult ranges from about 1 to 4 months. Only one generation is produced each year. No males of this insect have been found.

Control

The foliage of potatoes can be protected against vegetable weevil larvae and adults by dusting or spraying with parathion, aldrin, or DDT. Soil applications of chlordane and aldrin such as those recommended here for wireworm control have proved valuable in controlling the larvae in some sections.

Populations of the vegetable weevil can be reduced through crop rotation, soil preparation, clean cultivation, and destruction of crop remnants and of weeds on which the insect feeds. Infested ditch banks, hedgerows, and other margins of fields should be treated with one of the insecticides just named.

White-Fringed Beetles

White-fringed beetles, three species of which occur in the South, feed on potatoes and many other plants. They were discovered in Florida in 1936 and by the end of 1954 had been found in all the States from Florida and Louisiana to North Carolina and Tennessee.

The adult beetles are about one-half inch long and one-sixth inch across the body, dark gray with a lighter band along the margins of the wing covers. There are no males. Females lay eggs in masses of about 15 to 25, usually depositing them at points where such objects as sticks, gravel, and plant stems are in contact with soil. The insect spends the greater part of its life in the larval stage in the soil. One generation occurs each year.

The larvae, or grubs, feed on potato seed pieces, the stems and roots of the young plants, and the tubers (fig. 29). The full-grown larvae are about one-half inch long and are yellowish white, fleshy, curved, and legless. When numerous, this insect often destroys a potato crop almost completely.

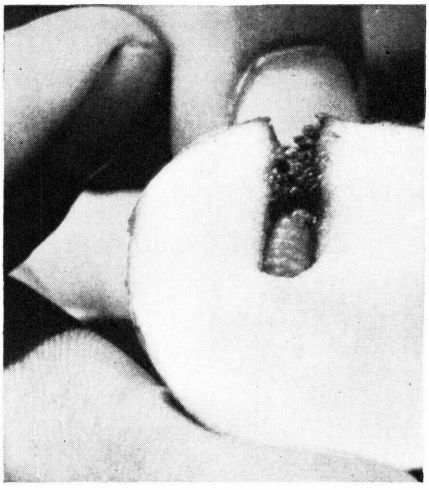

FIGURE 29.—White-fringed beetle larva feeding in a potato tuber.

Control

Injury to potatoes by white-fringed beetle larvae can be prevented by treating the soil, before the crop is planted, with dieldrin, aldrin, heptachlor, or chlordane, as recommended for control of wireworms. The insecticide should be worked into the top 3 or 4 inches of soil.

Similar use of 10 pounds of technical DDT per acre is effective, also, and one application lasts several years. One method is to apply 20 pounds of 50-percent DDT or 40 pounds of 25-percent DDT per acre with a dusting machine. To prevent drifting and blowing of the insecticide, make the application when the air is calm and point the nozzles of the machine downward. Foliage applications of DDT made primarily for control of the Colorado potato beetle and flea beetles are of value in reducing feeding of adult white-fringed beetles on potato plants. Fence rows, ditch banks, and roadways in and around the fields also should receive the DDT dust or sprays.

The following cultural practices will suppress white-fringed beetle infestations:

1. Plant oats, or other small grains, for grain and grazing, on the heavily infested part of the farm.

2. Do not plant more than one-fourth of your cropland each year to peanuts, soybeans, velvetbeans, or other plants that are favorable foods for the adult beetles. Do not grow such plants on the same land oftener than once in 3 or 4 years.

White Grubs

White grubs, the larvae of May beetles, occasionally cause considerable damage to potatoes by eating out large, shallow, circular holes in the tubers (fig. 30) and by feeding on other underground parts of the plants. The larvae have soft, whitish curved bodies, brown heads, 6 prominent legs, and large abdomens and are ¾ to 1 inch long when full grown.

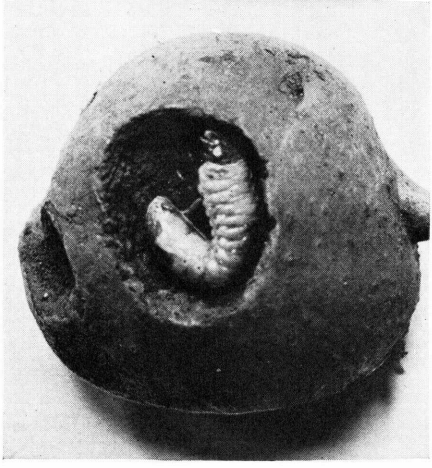

FIGURE 30.—White grub in the cavity it has eaten in a potato tuber. (Enlarged.)

Control

Potatoes should not be planted in soil known to be infested with white grubs, as they often are when pasture land is put in cultivation. A rotation involving the planting of a clean-cultivated crop ahead of po-

tatoes reduces the chance of white grub damage. Pasturing hogs on grub-infested land reduces the number of these insects. An application of one of the insecticides recommended for control of wireworms will usually protect potatoes adequately against light to moderate populations of white grubs.

USE OF INSECTICIDES

Successful use of insecticides depends on careful selection, preparation, and application. See that applications are begun before damage occurs. Use good equipment suitable for the size of the planting and capable of getting the insecticide to all parts of the plants. Keep this equipment clean and in good working order.

Dusts should be applied when there is little wind and the plants are moist with dew. Neither dusts nor sprays should be applied when the plants are dripping wet. Apply dusts at 20 to 35 pounds and sprays at 75 to 125 gallons per acre, unless applications at lower rates with special equipment have proved satisfactory under local conditions. Use the highest recommended rates if the insects have become abundant, if the plants are unusually large, or if the applications must be made during unfavorable weather.

Benzene hexachloride (BHC) and lindane (a refined form of that insecticide) should not be applied to potato foliage or be applied to the soil before a potato crop is planted, as they are likely to cause an off-flavor of the tubers.

Foliage applications should be made with the dosages given in table 2, and soil applications with those given in table 3.

TABLE 2.—*Insecticide dosages to be applied to potato foliage for control of certain insect pests in the South* [1]

Insecticide	Dust, to be applied at a rate of 20 to 35 pounds per acre		Spray	
	Strength	Insecticide per acre	Common formulation and quantity per acre [2]	Insecticide per acre
	Percent	*Pounds*		*Pounds*
Aldrin or heptachlor	2.5	0.5 to 0.87	23.4-percent (2 lb. per gal.) emulsion concentrate, 1 to 1½ qt	0.5 to 0.75.
			25-percent wettable powder, 2 to 3 lb	0.5 to 0.75.
Calcium arsenate	25	5 to 8.75	Undiluted, 5 lb	5.
Cryolite [3]	33 to 50	6.6 to 17.5	Undiluted (90-percent), 8 to 12 lb	7 to 11.
DDT	3	0.6 to 1	25-percent (2 lb. per gal.) emulsion concentrate, 2½ pt	0.625.
	5	1 to 1.75	50-percent wettable powder, 2 to 3 lb	1 to 1.5.
Dieldrin	1.5	0.3 to 0.52	15-percent (1.5 lb. per gal.) emulsion concentrate, 1¼ to 2½ pt.	0.25 to 0.5.
			50-percent wettable powder, 0.5 to 1 lb	0.25 to 0.5.
Malathion	4	0.8 to 1.4	50-percent (5 lb. per gal.) emulsion concentrate, 1½ to 2 pt	0.9 to 1.25.
			25-percent wettable powder, 3 to 5 lb	0.75 to 1.25.
Nicotine	3 to 4	0.6 to 1.4	40-percent nicotine sulfate, 1½ pt	0.6.
Parathion	1	0.2 to 0.35	25-percent emulsion concentrate, 10 fl. oz	0.15.
			15-percent wettable powder, 1 to 1½ lb	0.15 to 0.22.
Rotenone	0.75 to 1	0.15 to 0.35	5-percent emulsifiable concentrate, 1½ to 2 qt	0.15 to 0.2.
			5-percent powder, 4 to 5 lb	0.2 to 0.25.
Toxaphene	10	2 to 3.5	60-percent (6 lb. per gal.) emulsion concentrate, 2½ to 4 pt	1.88 to 3.
			40-percent wettable powder, 5 to 7 lb	2 to 2.8.

[1] For effective dosages for individual kinds of insect, see text. Use the higher dosages if the plants are unusually large, the insects are abundant, or the weather is unfavorable for dusting or spraying.

[2] Apply in 75 to 125 gallons of water per acre, unless applying in 25 to 50 gallons with special equipment has given satisfactory results under local conditions.

[3] Percentages are for sodium fluoaluminate.

TABLE 3.—*Commonly available insecticide formulations suitable to be applied to the soil of southern potato fields, and quantities of each that must be applied to provide certain dosages of the insecticide* [1]

Insecticide and formulation	Acre dosage of insecticide to be provided	Quantity of formulation to be applied per acre
	Pounds	
Aldrin:		
2.5-percent dust or granules	2–3	80–120 lb.
10-percent granules	2–3	20–30 lb.
23.4-percent (2 lb. per gal.) emulsion concentrate	2–3	1–1.5 gal.
25-percent wettable powder	2–3	8–12 lb.
Chlordane:		
10-percent dust or granules	2	20 lb.
	4	40 lb.
	6	60 lb.
45-percent (4 lb. per gal.) emulsion concentrate	2	2 qt.
	4	1 gal.
	6	1.5 gal.
40-percent wettable powder	2	5 lb.
	4	10 lb.
	6	15 lb.
DDT:		
10-percent dust or granules	10	100 lb.
25-percent (2 lb. per gal.) emulsion concentrate	10	5 gal.
50-percent wettable powder	10	20 lb.
Dieldrin:		
1.5-percent dust	2	134 lb.
5-percent granules	2	40 lb.
15-percent (1½ lb. per gal.) emulsion concentrate	2	1⅓ gal.
50-percent wettable powder	2	4 lb.
Heptachlor:		
2.5-percent dust or granules	2–3	80–120 lb.
5-percent granules	2–3	40–60 lb.
23.4-percent (2 lb. per gal.) emulsion concentrate	2–3	1–1.5 gal.
25-percent wettable powder	2–3	8–12 lb.

[1] For effective dosages for individual kinds of insect, see text.

Precautions

Most insecticides are poisons. Handle and use them with great care. Keep them out of reach of children and pets and where they cannot be mistaken for food or medicine. Follow all directions and heed all cautions on the labels.

Wash your hands and face thoroughly with soap and water after handling insecticides, especially before eating or smoking. Bathe after each day's work, and put on clean clothing each day.

Parathion is particularly poisonous and should be applied only by or under the supervision of a trained operator who will enforce the precautions prescribed by the manufacturer and assume full responsibility for safety. Parathion is extremely toxic if swallowed, inhaled, or absorbed through the skin; it may cause death. Do not attempt to prepare parathion dusts, but use them ready-mixed. Do not apply parathion to potatoes within 5 days before harvest.

Parathion, malathion, aldrin, chlordane, dieldrin, toxaphene, and heptachlor are absorbed through the skin. Anyone handling or applying

one of these materials should wear protective clothing. Do not let the insecticide remain on the skin.

NAMES OF POTATO INSECTS

Common Name	*Scientific Name*
Aphids:	
Green peach aphid	*Myzus persicae*
Potato aphid	*Macrosiphum solanifolii*
Blister beetles:	
Ash-gray blister beetle	*Epicauta fabricii*
Black blister beetle	*Epicauta pennsylvanica*
Margined blister beetle	*Epicauta pestifera*
Striped blister beetle	*Epicauta vittata*
Changa (a mole cricket)	*Scapteriscus vicinus*
Colorado potato beetle	*Leptinotarsa decemlineata*
Cutworms:	
Black cutworm	*Agrotis ypsilon*
Granulate cutworm	*Feltia subterranea*
Variegated cutworm	*Peridroma margaritosa*
Leaf-footed bug	*Leptoglossus phyllopus*
Leaf miners	*Liriomyza* spp.
Lygus bugs	*Lygus* spp.
Potato flea beetle	*Epitrix cucumeris*
Potato leafhopper	*Empoasca fabae*
Potato tuberworm	*Gnorimoschema operculella*
Seed-corn maggot	*Hylemya cilicrura*
Southern green stink bug	*Nezara viridula*
Southern mole cricket	*Scapteriscus acletus*
Thrips:	
Onion thrips	*Thrips tabaci*
Tobacco thrips	*Frankliniella fusca*
Vegetable weevil	*Listroderes costirostris obliquus*
White-fringed beetles	*Graphognathus* spp.
White grubs	*Phyllophaga* spp.
Wireworms:	
Gulf wireworm	*Conoderus amplicollis*
Southern potato wireworm	*Conoderus falli*

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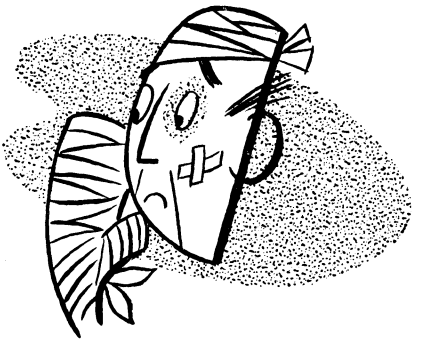
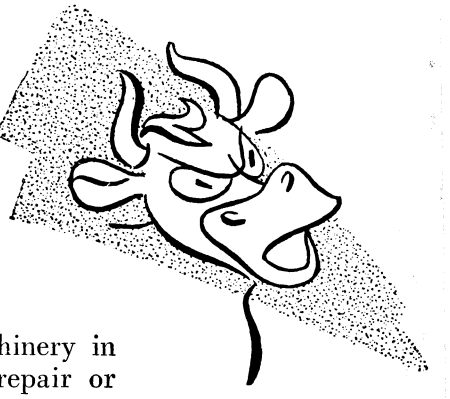
Farm Accidents Each Year . . .



- Kill about 15,000 people.
- Injure or cripple about 1¼ million more.
- Cause loss of 17 million man-days of farm labor, or the services of 46,000 men working every day for a year.

Help Prevent Most of These Accidents!



- Keep tractors and other farm machinery in good repair. Equipment in bad repair or carelessly handled ranks first in killing or injuring farm people.
- Handle bulls and other farm animals carefully. They rank second in causing farm accidents and deaths.
- Use sharp-edged tools with caution—sickles, saws, corn knives, chisels, screwdrivers, axes.
- Take proper care in using, handling, and storing insecticides and other poisonous chemicals.
- Install, use, and repair electrical appliances and equipment properly.

You can lessen the seriousness of many accidents by immediate and proper care. Keep a first aid kit handy and know how to use it. **Call a doctor.**